

Chapter 7

ENVIRONMENTAL SURVEILLANCE

7.1 Policy

It is DOE policy to conduct its operations in an environmentally responsible manner and comply with applicable environmental regulations and standards. At BNL, a wide variety of environmental activities are conducted to demonstrate compliance with federal, state, and local regulations. This chapter summarizes the results of the BNL Environmental Monitoring Program, which consists of the collection and analysis of samples of air, water, soil, sediment, vegetation, foodstuffs, and biota from the local area. The program also includes measuring external radiation to demonstrate compliance with applicable standards, to assess radiation exposure to members of the public, and to assess effects, if any, on the local environment.

7.2 External Radiation Monitoring

BNL measures of environmental background radiation through a network of on-site and off-site dosimeter units. These units, called thermoluminescent dosimeters, or TLDs, measure gamma radiation originating from cosmic and terrestrial sources (see Section 4.1 for discussion) as well as any contribution from Laboratory operations. Calcium fluoride ($\text{CaF}_2\text{:Dy}$) type TLDs are used. There are 24 on-site locations which have TLDs in place (Figure 7-1). In addition to the dosimeters on Laboratory property, 25 off-site locations are monitored (Figure 7-2) to provide background comparisons and verification that Laboratory operations have had no impact on the ambient radiation levels of the surrounding area.

The 1997 TLD data are summarized in Table 7-1. Each TLD is exposed for one calendar quarter. The annual external radiation dose quoted for each location is the sum of four separate measurements. Where the total number of samples collected is less than four, theft, vandalism, or loss of the unit due to other reasons has occurred. For ease of comparison, all individual measurements have been summed and normalized to a 365 day exposure period to calculate a single annual value.

The average annual off-site external radiation dose value was 67 ± 5 mrem (0.67 ± 0.05 mSv) (the error term represents the standard deviation of the sample population). This is consistent with the value of 67 ± 7 mrem/yr (0.67 ± 0.07 mSv/yr) measured in 1996. The average on-site external radiation dose rate was 70 ± 6 mrem/yr (0.70 ± 0.06 mSv/yr). These average values are statistically indistinguishable and are within the normal background exposure range typical of the northeastern part of the United States (NCRP, 1987). The measurements recorded from the TLD program cannot be used to assess exposure due to internally deposited radionuclides or inhaled radon progeny. Figure 7-3 presents average on-site and off-site doses for the past five years.

7.2.1 Building 650 Sump Outfall Monitoring

From approximately 1959 to 1969, radiologically contaminated heavy equipment was decontaminated on a concrete pad adjacent to Building 650. The drainage from this pad was designated for containment in underground storage tanks. However, in 1969 it was determined that the drainage system for the pad was not routed as facility operators believed it to be; it was instead routed to a depression in a wooded area approximately 800 feet northeast of Building 650. This depression is referred to as the Building 650 Sump Outfall. It is a source of localized radiological soil and groundwater contamination which is being remediated through the CERCLA program (OU IV, AOC 6). Identified radionuclides in soil include strontium-90, cesium-137, and isotopes of europium and plutonium.

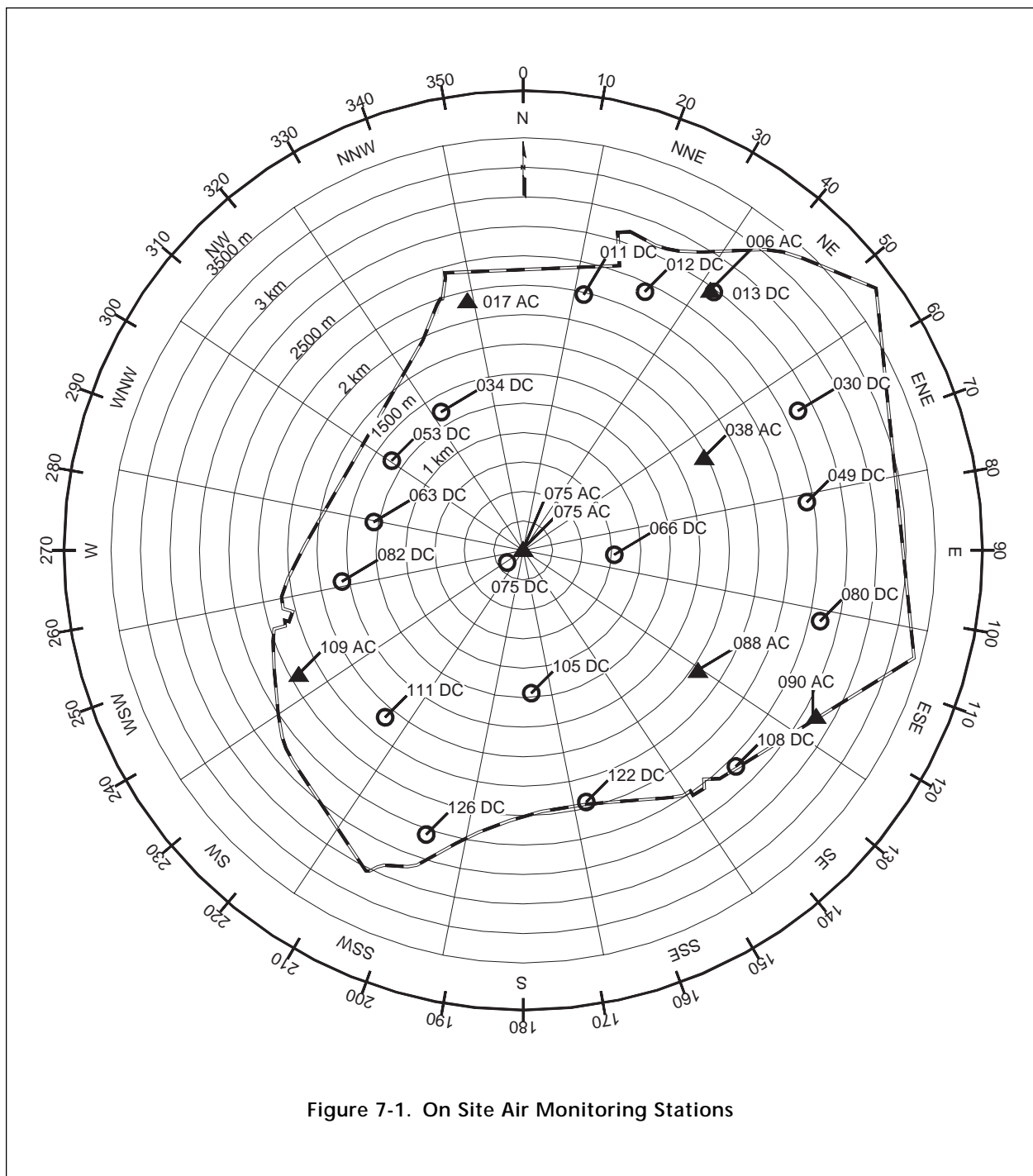


Figure 7-1. On Site Air Monitoring Stations

As part of the OU IV Interim Remedy Plan, the Outfall was fenced to exclude pedestrian traffic, and a network of 16 TLDs was installed in 1997 to monitor gamma radiation exposure levels in the area (Figure 7-4). Four fence perimeter dosimeters were also installed, as well as two background dosimeters located at the site of the 11th International Intercomparison of Environmental Dosimeters, an area uninfluenced by AOC 6 or other site radiation sources.

Data from these dosimeters indicate that the highest concentration of radionuclides is located in the area of position C4, where a dose rate of 1.4 rem/yr (0.14 Sv/yr) was recorded (Table 7-2).

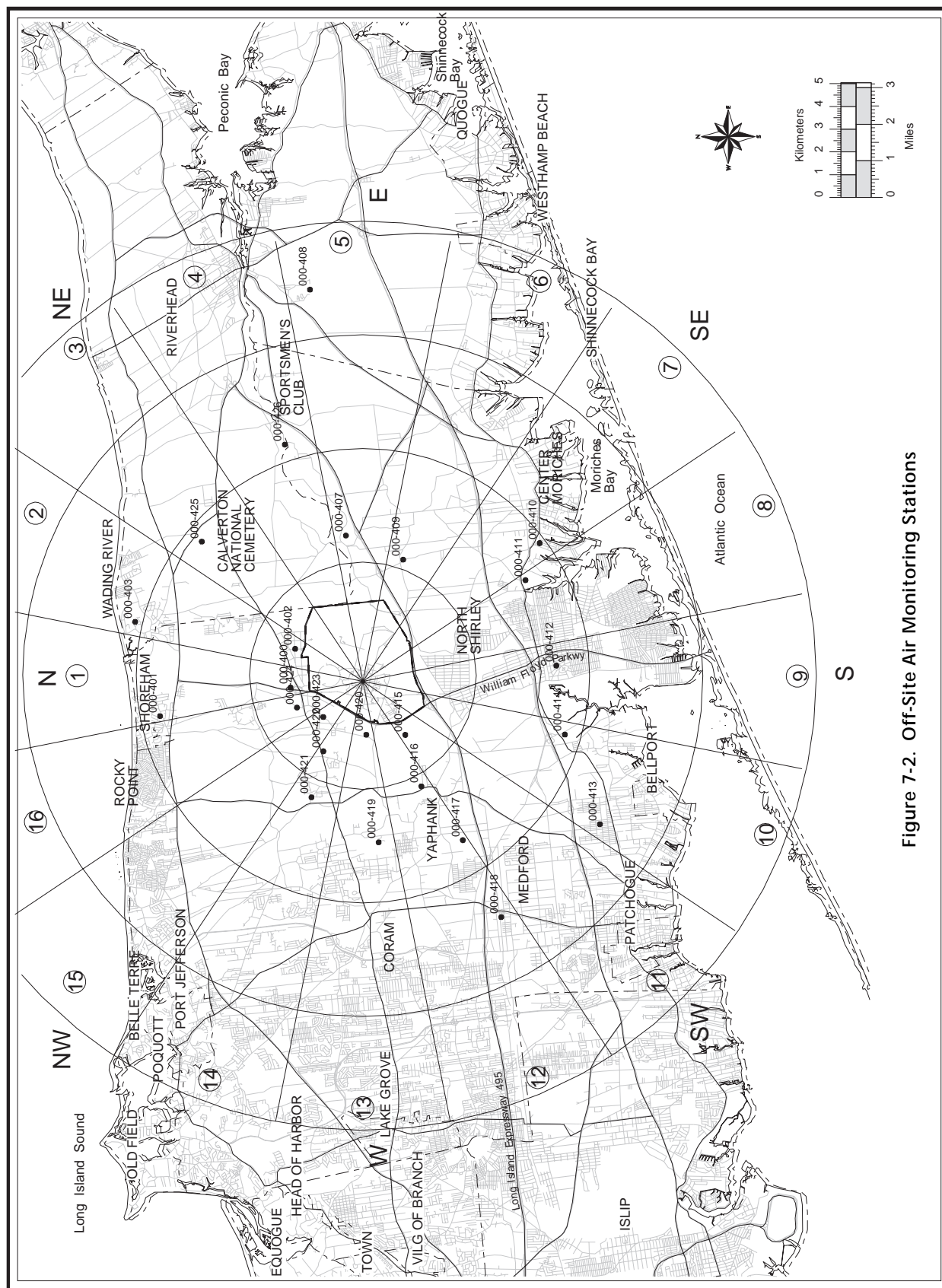


Figure 7-2. Off-Site Air Monitoring Stations

Table 7-1
BNL Site Environmental Report for Calendar Year 1997
On-Site and Off-Site Annual Exposure Measurements

Station (Grid-ID)	No. of TLDs Collected	Exp. Period (Days)	Annual Dose* (mrem/yr)	Station (Grid-ID)	No. of TLDs Collected	Exp. Period (Days)	Annual Dose* (mrem/yr)
On-Site Locations				Off-Site Locations			
011-400	4	365	66	000-400	4	277	63
013-400 (P9)	4	365	68	000-401	3	245	60
017-400 (P2)	4	365	59	000-402	3	247	67
030-400	4	365	67	000-403	4	375	73
034-400	4	365	74	000-407	4	375	61
034-401	4	365	73	000-408	4	377	60
037-400	4	365	67	000-409	4	375	61
038-450 (S5)	4	365	68	000-410	4	375	64
049-400	3	283	66	000-411	4	359	71
049-400	4	365	75	000-412	4	375	73
063-400	4	365	79	000-413	4	371	69
066-400	4	365	57	000-414	4	357	70
073-400	4	365	75	000-415	4	375	60
074-450 (Bldg. 197)	4	365	73	000-416	4	371	60
074-451 (Bldg. 907)	4	365	61	000-417	4	365	64
080-400	4	365	77	000-418	4	368	67
082-400	4	365	79	000-419	4	363	65
090-400 (P7)	4	365	73	000-420	3	229	69
105-400	4	365	64	000-421	3	270	78
108-450	3	283	72	000-422	4	357	67
109-400 (P4)	4	365	71	000-423	3	256	71
111-400	4	365	73	000-424	4	357	72
122-400	4	365	71	000-425	4	357	64
126-400	4	365	81	000-426	3	229	73
				000-427	3	281	68
Average Value =			70 mrem	Average Value =			67 mrem
Median Value =			72 mrem	Median Value =			67 mrem
Population Standard Deviation =			6 mrem	Population Standard Deviation =			5 mrem

* Dose rate normalized to a 365 day year.

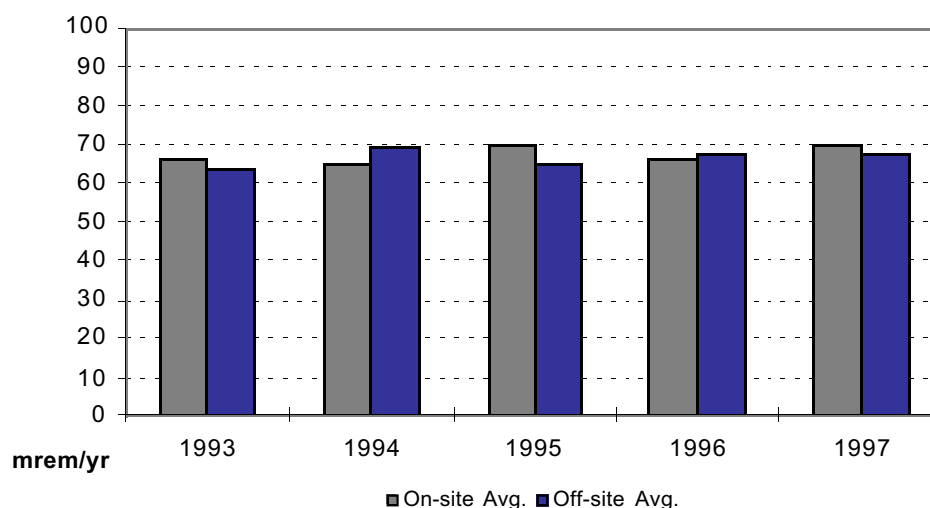


Figure 7-3. Environmental TLD Measurements, 5-Year Trend

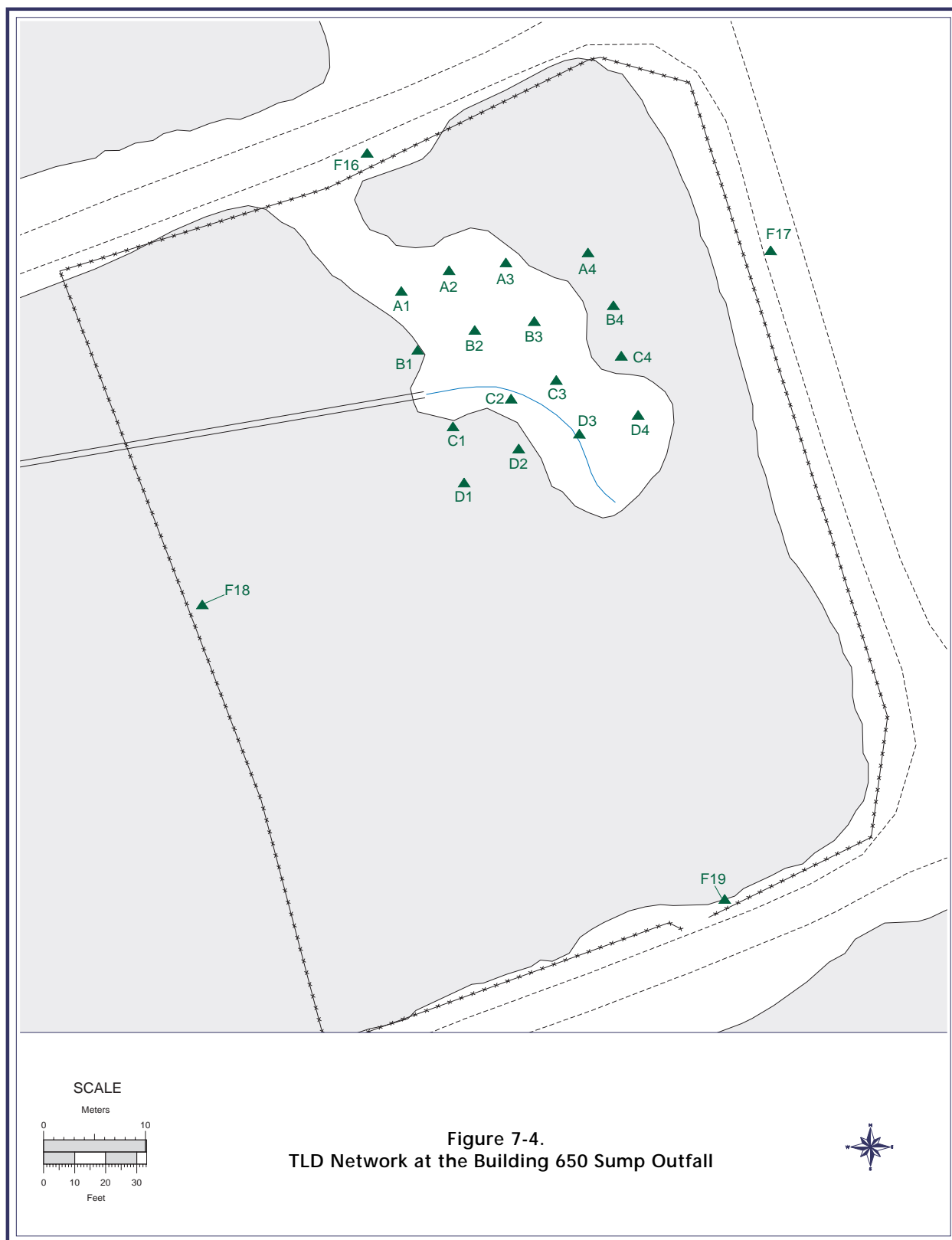


Figure 7-4.
TLD Network at the Building 650 Sump Outfall

Table 7-2
BNL Site Environmental Report for Calendar Year 1997
Bldg. 650 Sump Outfall TLD Network Data

Location	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Total (mrem/yr)
	(mrem)				
A1	19	20	19	21	78
A2	69	73	74	73	290
A3	25	25	27	27	103
A4	19	21	20	21	80
B1	16	17	17	17	67
B2	36	40	38	38	152
B3	80	80	79	80	318
B4	37	39	39	39	153
C1	20	21	21	22	83
C2	45	49	47	47	187
C3	164	167	173	171	674
C4	348	357	362	344	1411
D1	20	19	21	20	80
D2	29	32	30	32	122
D3	128	132	128	132	519
D4	193	199	200	197	789
Fence, N	13	14	13	14	54
Fence, S	13	13	13	13	51
Fence, E	15	15	15	15	60
Fence, W	15	14	15	15	60
Bkg 1 *	15	15	15	16	61
Bkg 2 *	15	14	15	16	60

* Distant background locations.

Other locations showed dose rates which varied from background levels up to 789 mrem/yr (7.9 mSv/yr). Fence dosimeters showed no elevated dose rates and were consistent with the two distant background TLDs, demonstrating that the radiation field generated by the Sump Outfall contaminants is limited to the immediate area of the Outfall itself. The Building 650 Sump Outfall is not an exposure hazard for either site workers nor the surrounding public.

7.3 Atmospheric Radiological Monitoring

As part of the environmental air monitoring program, six stations are in place around the BNL site which sample the air for (non-tritium) radioactive content. Glass fiber filter paper is used to capture airborne particulate matter and charcoal cartridges are used to collect radioiodines, should any be present. Filter paper is collected weekly and analyzed for gross alpha and beta activity using a proportional counter, while charcoal cartridges are collected monthly and analyzed using gamma spectroscopy. No radioiodines were detected in these samples in 1997.

In addition to these samples, the NYSDOH receives duplicate filter samples which are collected at Station P7 in BNL Grid 090 (southeast boundary). These samples are also collected on a weekly basis and are analyzed by an independent NYSDOH Laboratory. Analysis results are reported annually in a document called "Environmental Radiation In New York State". As part of their state wide monitoring program, the NYSDOH collects air samples in Albany, NY, a control location uninfluenced by nuclear facility effluents (NYSDOH, 1993). The NYSDOH reports that typical airborne gross beta activity at that location varies between 0.005 and 0.025 pCi/m³ (0.2 to 0.9 mBq/m³).

Table 7-3
BNL Site Environmental Report for Calendar Year 1997
Gross Activity Detected in Air Particulate Filters

Sample Station	Grid Location		Gross Alpha (pCi/m ³)	Gross Beta (pCi/m ³)
P2	017	N	52	52
		NBD	51	0
		Max.	0.002 ± 0.001	0.029 ± 0.003
		Avg.	0.001 ± 0.001	0.015 ± 0.010
P4	109	N	52	52
		NBD	51	0
		Max.	0.002 ± 0.001	0.022 ± 0.003
		Avg.	0.001 ± 0.001	0.014 ± 0.008
P7	090	N	52	52
		NBD	51	2
		Max.	0.003 ± 0.003	0.021 ± 0.003
		Avg.	0.001 ± 0.001	0.012 ± 0.010
P9	006	N	52	52
		NBD	45	2
		Max.	0.005 ± 0.001	0.023 ± 0.007
		Avg.	0.001 ± 0.002	0.014 ± 0.010
S5	038	N	36	36
		NBD	36	0
		Max.	0.003 ± 0.002	0.023 ± 0.002
		Avg.	0.001 ± 0.001	0.015 ± 0.009
S6	088	N	52	52
		NBD	50	3
		Max.	0.003 ± 0.001	0.023 ± 0.003
		Avg.	0.001 ± 0.001	0.014 ± 0.011

N = Number of samples collected.

NBD = Number of samples below detection limit.

Particulate filter analysis results are reported in Table 7-3. Annual average gross alpha activity levels were equal to 0.001 pCi/m³ (0.04 mBq/m³), while gross beta results ranged from undetectable to 0.029 pCi/m³ (1.1 mBq/m³). Annual gross beta activity trends are plotted in Figures 7-5 through 7-7 for all sampling stations. These trends show a seasonal variation of concentrations within a range representative of natural background. (Gross alpha activity is not plotted because the vast majority of results are below the analytical detection limit.) Measurable activity is primarily due to radionuclide decay products associated with natural uranium and thorium. Data issued by NYSDOH for the Albany control location indicates results similar to those obtained at BNL, demonstrating that radiological air quality is consistent with that observed in other parts of NY State not located near radiological facilities.

7.3.1 Airborne Tritium Monitoring

Airborne tritium in the form of tritiated water vapor (HTO) is monitored throughout the BNL site. Twenty monitors are located at or near the property boundary (Figure 5-1). HTO is collected by a pump that draws air through a column of silica gel, a water-absorbent medium which retains atmospheric moisture. The absorbed water is recovered in the Analytical Services Laboratory and analyzed using liquid scintillation techniques (Appendix C describes the methodology).

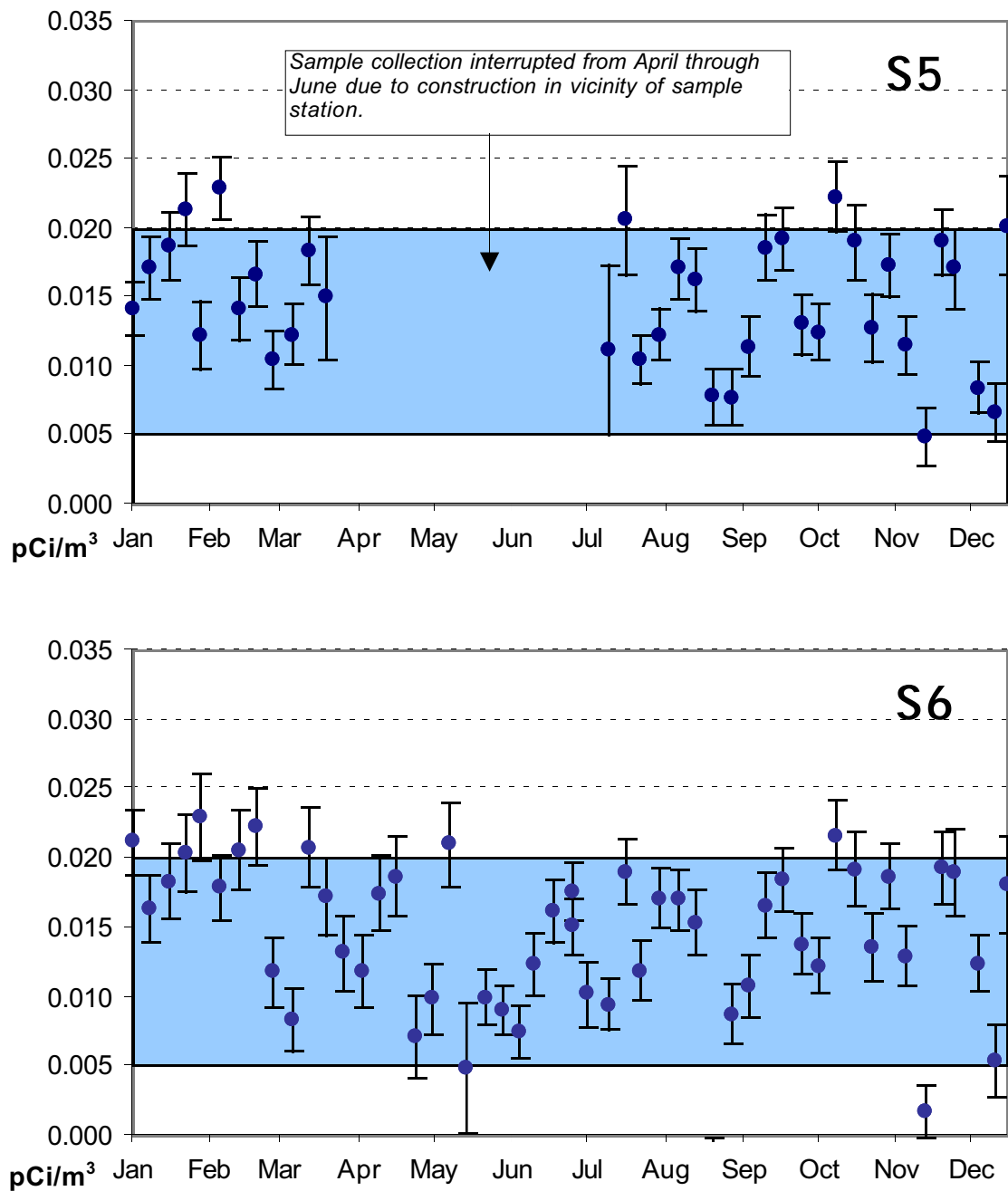


Figure 7-5. Gross beta trend data for air particulate samples at Stations S5 and S6. (Shaded area indicates typical background range reported by NYSDEC in Albany, N.Y.)

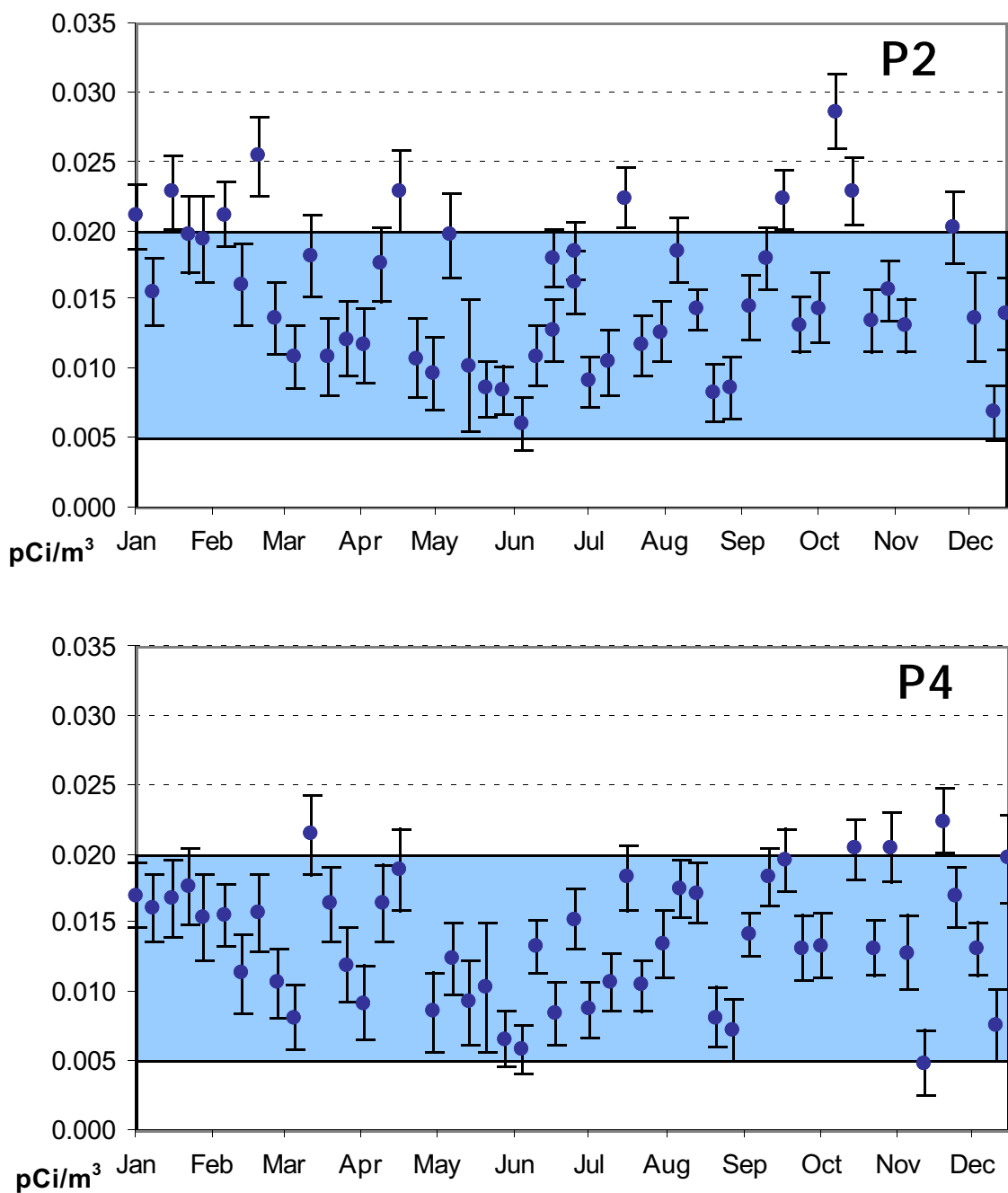


Figure 7-6. Gross beta trend data for air particulate samples at Stations P2 and P4. (Shaded area indicates typical background range reported by NYSDEC in Albany, N.Y.)

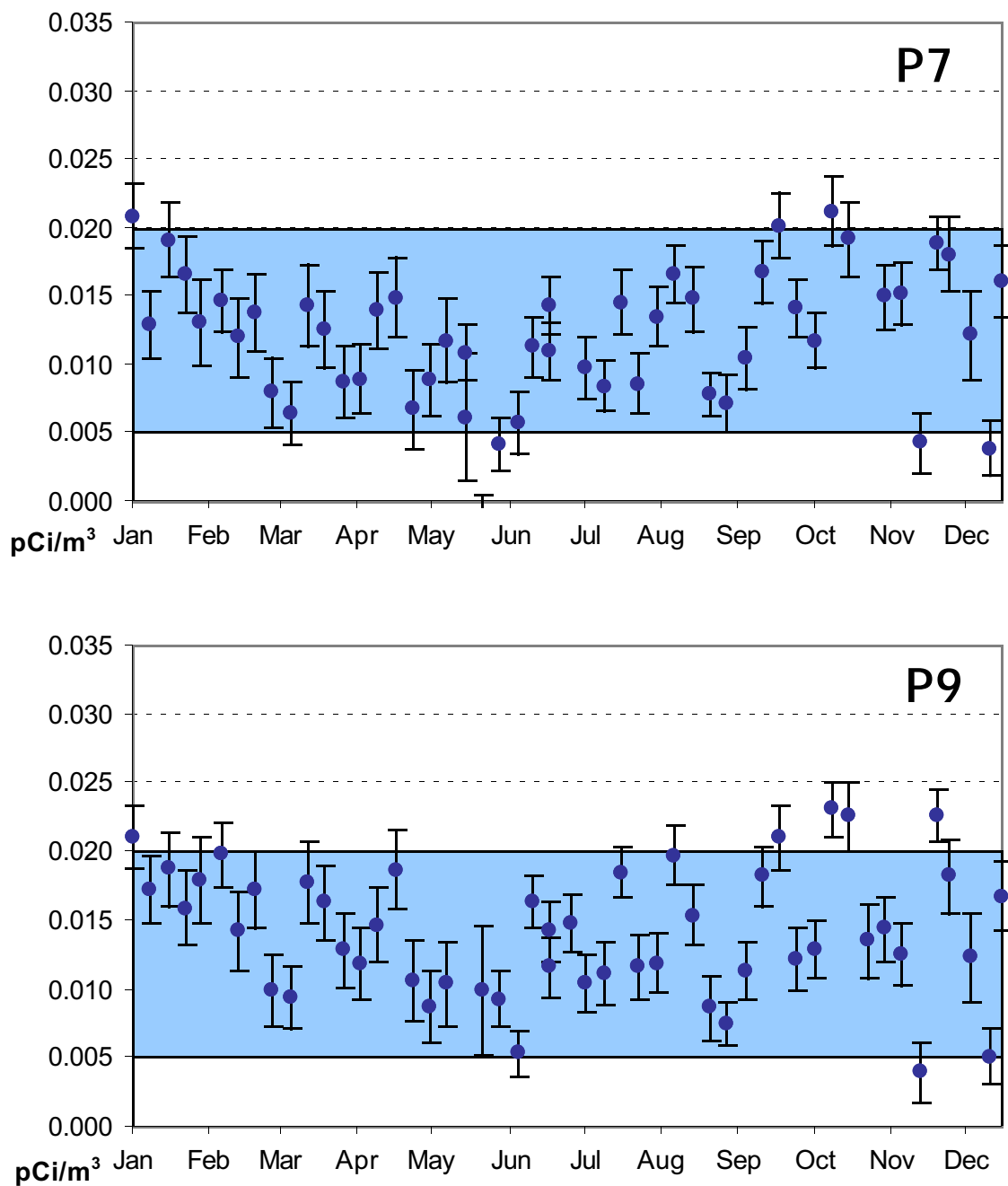


Figure 7-7. Gross beta trend data for air particulate samples at Stations P7 and P9. (Shaded area indicates typical background range reported by NYSDEC in Albany, N.Y.)

Table 7-4
BNL Site Environmental Report for Calendar Year 1997
Ambient Airborne Tritium Measurements

BNL Grid Location	Wind Sector	No. of Validated Samples	Maximum (pCi/m ³)	Average (pCi/m ³)
006	NE	50	8.8 ± 3.4	0.2 ± 4.0
011	NNE	44	6.4 ± 5.0	-0.6 ± 4.9
012	NNE	36	9.1 ± 3.3	0.2 ± 3.7
017	NNW	48	6.5 ± 3.3	-0.1 ± 3.7
030	ENE	38	9.2 ± 2.7	-0.3 ± 5.8
034	NNW	44	4.1 ± 1.3	-0.8 ± 4.3
049	E	43	5.6 ± 1.2	-0.8 ± 8.0
053	NW	40	10.9 ± 3.8	-0.2 ± 5.8
063	W	40	2.8 ± 1.1	-0.6 ± 3.7
066	E	26	5.9 ± 4.2	-0.4 ± 9.8
075	SW	39	14.4 ± 5.5	0.7 ± 6.1
080	ESE	43	14.4 ± 2.4	0.4 ± 7.4
082	W	45	17.7 ± 2.0	-0.5 ± 7.0
090	ESE	47	50.4 ± 3.0	1.4 ± 16.1
105	S	44	6.1 ± 2.2	-0.1 ± 4.2
108	SE	47	17.0 ± 5.8	0.4 ± 6.5
109	WSW	49	13.9 ± 3.4	-0.1 ± 5.4
111	SW	44	14.1 ± 3.5	-1.0 ± 8.3
122	SSE	43	4.1 ± 4.0	-0.2 ± 3.9
126	SSW	44	6.7 ± 2.2	-0.2 ± 4.0
Average =				1.3 ± 15.7

Notes:

1. Maximum values reported with 95% confidence interval.
2. Average values reported as arithmetic mean with ± 2 population standard deviations.
3. Typical minimum detection limit = 4 pCi/m³.

Table 7-4 lists the number of samples collected at each location, the maximum value observed and the annual average concentration. While each location showed a maximum value at some point in the year which was above the typical detection limit of about 4 pCi/m³ (0.15 Bq/m³), the vast majority of sample results were below the detectable level. These data demonstrate that there is no significant increase in ambient tritium concentrations at the site boundary as a result of Laboratory operations. All annual average concentrations were below the analytical detection limit. The maximum concentration recorded in a single measurement occurred at the station located in BNL Grid 090, the Laboratory's southeastern boundary; the concentration was 50 pCi/m³ (1.9 Bq/m³). By comparison, the DOE Order 5400.5 DCG for tritium in air is 100,000 pCi/m³ (3.7 kBq/m³). The airborne DCG is the concentration of a radionuclide in air which, if inhaled at that level for one year, would result in an effective dose equivalent of 100 mrem (1 mSv) to the exposed individual. Only three out of 47 samples collected at the Grid 090 station were above the MDL during 1997.

7.3.2 RA V Recharge Basin

Airborne monitoring was also conducted in the vicinity of the RA V Recharge Basin to determine whether tritium in the basin presented a potential airborne fugitive emission source (Section 5.2). Two monitors were installed immediately adjacent to the basin at the northeast and south-

Table 7-5
BNL Site Environmental Report for Calendar Year 1997
Ambient Tritium Monitoring Results at RA V Recharge Basin

Location	No. of Samples	Detections		pCi/m ³
Northeast corner of basin	12	2	Max. Avg.	11.7 ± 1.6 1.2 ± 8.5
Southeast corner of basin	14	0	Max. Avg.	< 2.3 0.6 ± 1.4
National Weather Service Building	13	3	Max. Avg.	3.6 ± 2.1 0.8 ± 3.3

Typical MDL between 1 to 4 pCi/m³.

east corners, the downwind directions of the predominant winds on site. An additional station was placed near the National Weather Service building, approximately 0.3 km (900 ft.) to the east of the basin. Table 7-5 shows that no trend of measurable airborne tritium was observed. Only five of 39 total samples showed results greater than the detection limit, and those five were at values consistent with what was observed throughout the site. This is as expected since direct analysis of the basin water showed tritium values which were rarely large enough to be detected, i.e., < 1,000 pCi/L (< 37 Bq/L).

7.4 Precipitation Sampling

As part of the environmental monitoring program, precipitation samples are collected approximately once a month at Stations P4 and S5 (located in BNL Grids 109 and 038) and analyzed for radioactive content (Table 7-6 and Figure 5-1). Measurements of gross alpha activity samples collected at both stations indicated average values below the typical minimum detection limit of 2 pCi/L (0.07 Bq/L). Gross beta activity was occasionally measurable at levels at or slightly above typical MDLs, although gamma spectroscopy analysis confirmed the absence of any anthropogenic radionuclides. Tritium values for the precipitation samples were near or below the minimum detection limit for all 20 samples, indicating that the Laboratory's airborne emissions had no measurable impact on local rainwater or snowfall.

Table 7-6
BNL Site Environmental Report for Calendar Year 1997
Radiological Analysis of Precipitation

Station	Grid	Compass Sector	N		Gross Alpha (pCi/L)	Gross Beta	Tritium
P4	017	WSW	10	Max.	3.6 ± 2.4	10.9 ± 5.5	355 ± 202*
				Avg.	1.5 ± 2.1	5.4 ± 4.8	-25 ± 284
S5	038	ENE	10	Max.	3.3 ± 2.2	8.3 ± 5.1	< 263
				Avg.	0.9 ± 2.3	4.3 ± 3.8	-9 ± 170

N= Number of samples collected.

* MDL for this data point = 303 pCi/L.

7.5 Terrestrial and Ecological Radioactivity Studies

BNL maintains a soil and vegetation-sampling program for the site, including semiannual fauna-sampling, first initiated in 1992. In 1992 and 1993 samples were collected which included a wide variety of on-site species such as fox, raccoon, rabbit, skunk, opossum, and muskrat. On-site fauna sampling was again conducted in 1997, but was limited to the deer population. Similarly, an on-site soil and vegetation collection program was begun in 1993. This program calls for sampling every five years, so on-site sampling was not conducted in 1997. However, as part of a cooperative effort between BNL and the SCDHS, vegetation, fruit and soil samples from farms in the vicinity of the Laboratory are collected annually.

7.5.1 Radiological Analysis of Deer

A deer population study for the BNL site conducted in 1992 indicated that the total number of deer on site might be as high as 700. Since there are no natural predators on site and no sport hunting, there are no significant pressures on the population to migrate beyond their typical geographical range of approximately one mile. Recent destruction of habitat to the southwest of BNL property and the resulting influx of deer has contributed to the size of the on-site population.

Deer in New York State typically grow to large sizes, with males having average weights of approximately 68 kg (150 lbs.); females are slightly less at about 45 kg. (100 lbs.). However, deer on Long Island tend to be much smaller, with an average weight of less than 36 kg (80 lbs.). The available meat on local deer ranges from 9 to 18 kg (20 to 40 lbs.) per deer.

In 1997, an off-site deer-sampling program was again conducted in cooperation with the NYSDEC Wildlife Branch. Licensed hunters were approached by the NYSDEC at checkpoints where meat and liver samples were requested. However, due to limited support from local hunters, only two samples were obtained from off-site locations adjacent to the Laboratory. Therefore, the majority of samples collected are from the BNL site. All on-site samples were obtained from deer killed by cars. Samples were analyzed for gamma-emitting radionuclides; the results are shown in Table 7-7. It was previously established that deer taken on BNL property contain cesium-137 concentrations at levels above those taken from off-site (see the BNL Site Environmental Report for Calendar Year 1996). This is most likely the result of deer grazing in areas where elevated cesium-137 levels are known to exist in soils. Cesium contained in these soils is transferred to plant matter via root uptake, where it then becomes available for consumption by browsing animals.

The maximum concentration of cesium-137 detected in hind meat samples was 6.0 pCi/g (0.22 Bq/g); this sample was collected near Bldg. 555 on Center Street. The average concentration of all samples of hind meat in which cesium was detected was 1.8 pCi/g (0.07 Bq/g). This average includes the sample collected by the NYSDEC to the northeast of the site which showed a concentration of 4.7 pCi/g (0.17 Bq/g). This result appears consistent with values previously observed in on-site samples, suggesting that this animal may have migrated from an on-site location. Figure 7-8 shows the ranges of cesium-137 concentrations in on-site deer sampled since 1992.

7.5.2 Radiological Analysis of Vegetation

In August 1997, vegetation and soil samples were collected from farms surrounding BNL and locations further away from the Laboratory, and were analyzed by the BNL ASL for gamma-emitting radionuclides. The results are shown in Table 7-8 and show the presence of potassium-40 at levels which are consistent with expectations for this type of environmental sample. No radionuclides attributable to Laboratory operations were detected. While cesium-137 was detected in a few vegetation samples, the results are typical of levels due to fallout observed in the United States (Golchert and Kolzow 1994).

Table 7-7
BNL Site Environmental Report for the Calendar year 1997
Radiological Analysis of Deer Meat

Location	Sex	Date Collected	Tissue Analyzed	K-40	Cs-137
				(pCi/g, wet)	
Main gate	doe	13-Oct-97	Hind Meat	2.51 ± 0.48	0.23 ± 0.05
			Liver	3.51 ± 0.98	0.50 ± 0.12
Bldg. 1001	doe	18-Nov-97	Hind Meat	3.27 ± 0.58	1.35 ± 0.24
			Liver	2.24 ± 0.41	0.41 ± 0.07
Bldg. 830	doe	8-Oct-97	Hind Meat	2.81 ± 0.68	2.39 ± 0.56
			Liver	1.68 ± 0.30	0.21 ± 0.04
Bldg. 830	doe	7-Oct-97	Hind Meat	3.19 ± 0.54	0.19 ± 0.04
			Liver	1.84 ± 0.33	0.03 ± 0.01
Center St/ Chemistry Bldg.	buck	7-Sep-97	Hind Meat	2.81 ± 0.47	6.04 ± 1.03
			Liver	2.21 ± 0.40	3.73 ± 0.64
Railroad Avenue	doe	10-Nov-97	Hind Meat	3.58 ± 0.60	1.04 ± 0.16
			Liver	1.68 ± 0.29	0.16 ± 0.03
0.5 mi. SW of Shultz Road/Wading River- Manorville Rd (NYSDEC)	doe	13-Nov-97	Hind Meat	1.94 ± 0.33	4.71 ± 0.80

ND = Not Detected.

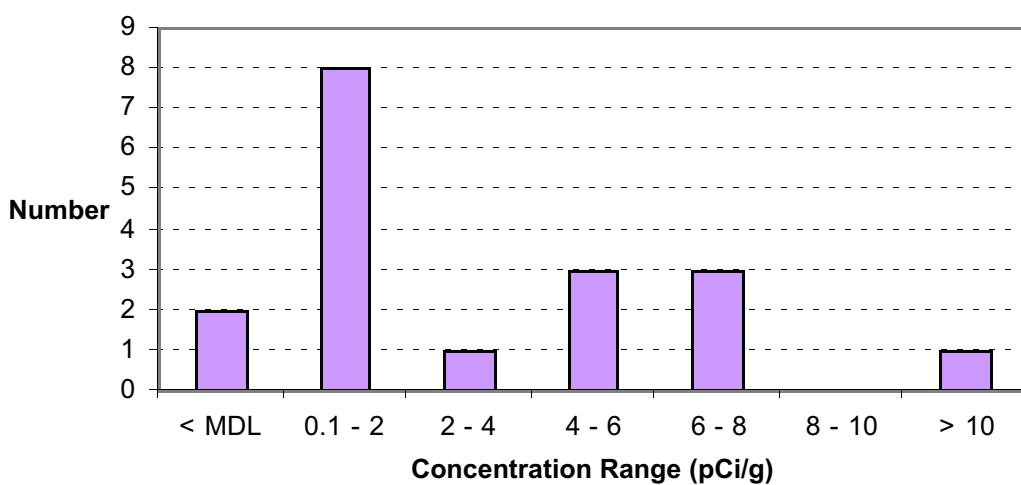


Figure 7-8. Distribution of Cs-137 in On-site Deer Collection Since 1992

Table 7-8
BNL Site Environmental Report for Calendar Year 1997
Radiological Analysis of Vegetation Samples

Sample Location	Sample Type	K-40	Cs-137
		(pCi/g, wet)	
Farm A 6 km (3.7 mi.) northeast of BNL site.	Italian hot peppers	6.0 ± 1.5	ND
	Strawberries	1.5 ± 0.3	ND
	Sweet corn	4.2 ± 1.0	ND
			ND
Farm B 22.4 km (14 mi.) east-northeast of BNL site	Tomato	1.9 ± 0.3	ND
	Yellow squash	2.5 ± 0.4	ND
	Sweet corn	2.0 ± 0.4	ND
			ND
Farm C 5 km (3 mi.) east-southeast of BNL site.	Yellow squash	1.4 ± 0.3	ND
	Broccoli - stems/	4.7 ± 1.3	ND
	leaves		ND
	Eggplant	2.0 ± 0.4	ND
	Yellow squash	1.5 ± 0.2	0.01 ± 0.004
	Zucchini	1.7 ± 0.4	ND
	Broccoli - stems	4.9 ± 1.0	ND
	Broccoli - florets	5.6 ± 1.2	ND
	Sweet corn	2.2 ± 0.4	ND
Farm D 6.4 km (4 mi.) southwest of BNL site.	Tomato	1.6 ± 0.3	ND
	Feed corn	2.1 ± 0.4	ND
	Pumpkin seeds	3.2 ± 0.6	0.02 ± 0.01
	Pumpkin flesh	1.4 ± 0.3	ND
	Pumpkin flesh	1.5 ± 0.2	0.01 ± 0.004
	Pumpkin flesh	1.6 ± 0.5	ND

ND = Not Detected

All samples collected on August 20, 1997.

7.5.3 Radiological Analysis of Soils and Sediments

Sediment samples were collected from Flanders Bay, Swan Pond, and the Carmans River (Swan Pond and the Carmans River were used as control locations), and soil samples were collected from farms in the vicinity of the Laboratory. These samples were analyzed for gamma-emitting radionuclides. The results are presented in Table 7-9. These data confirmed the presence of natural radionuclides such as potassium-40 and lead-212 at uniform levels in the marine and terrestrial environments sampled. Cesium-137, a globally distributed radionuclide, was detected in two out of five sediment samples at extremely low levels close to the detection limits of the analytical system. The cesium-137 concentration in sediment from Flanders Bay did not differ from those collected at the control location of the Carmans River.

7.6 Peconic River Surveillance

7.6.1 Peconic River Surveillance - Non-radiological Analyses

The Peconic River was sampled at six locations during 1997; three on-site (Sampling Locations HMn, HMs and HQ) and four off-site (Sampling Locations HA, HB, HC, and HR) (Figure 7-9). In addition, the Carmans River was also sampled (Location HH) as an off-site control location. These samples were analyzed for water quality parameters (i.e., pH, temperature, conductivity, and dis-

Table 7-9
BNL Site Environmental Report for Calendar Year 1997
Radioanalysis of Soils and Sediment

Sample Location	Sample Date	Sample Type	K-40	Cs-137	Tl-208	Pb-212 (pCi/g, wet)	Pb-214	Bi-214	Ac-228	Th-232
NYS Farm	20-Aug-97	Soil	5.47 ± 1.84	0.44 ± 0.13	0.35 ± 0.14	0.51 ± 0.24	0.67 ± 0.21	ND	ND	ND
Yaphank Honor Farm (Site A)	20-Aug-97	Soil	6.11 ± 1.09	0.16 ± 0.05	0.24 ± 0.06	0.78 ± 0.12	0.66 ± 0.16	0.80 ± 0.11	0.72 ± 0.12	0.98 ± 0.23
Yaphank Honor Farm (Site B)		Soil	7.09 ± 1.25	0.15 ± 0.05	0.33 ± 0.07	0.98 ± 0.15	0.82 ± 0.17	0.95 ± 0.12	0.93 ± 0.13	0.99 ± 0.25
Yaphank Honor Farm (Site C)		Soil	6.34 ± 1.24	0.26 ± 0.07	0.35 ± 0.08	0.91 ± 0.15	1.14 ± 0.16	1.10 ± 0.16	0.91 ± 0.17	0.88 ± 0.34
Lewins Farm (Site A)	2-Jul-98	Soil	8.55 ± 1.44	0.21 ± 0.05	0.39 ± 0.07	1.09 ± 0.15	1.15 ± 0.14	1.07 ± 0.12	1.17 ± 0.13	1.00 ± 0.22
Lewins Farm (Site B)		Soil	7.67 ± 1.30	0.12 ± 0.04	0.34 ± 0.06	0.95 ± 0.13	0.86 ± 0.11	0.83 ± 0.11	1.01 ± 0.12	1.05 ± 0.41
Glover's Farm	24-Jun-97	Soil	11.82 ± 2.52	ND	0.76 ± 0.18	2.29 ± 0.43	2.03 ± 0.36	1.73 ± 0.28	2.24 ± 0.39	2.13 ± 0.70
Bruno's Farm	20-Aug-97	Soil	7.46 ± 1.86	0.15 ± 0.10	0.38 ± 0.14	0.89 ± 0.20	1.14 ± 0.24	1.29 ± 0.28	1.10 ± 0.32	ND ± 0.00
May's Farm (Site A)	2-Jul-97	Soil	7.63 ± 1.34	ND	0.40 ± 0.07	0.95 ± 0.14	0.99 ± 0.19	0.95 ± 0.12	1.00 ± 0.13	1.07 ± 0.25
May's Farm (Site B)	20-Aug-97	Soil	6.32 ± 1.11	0.05 ± 0.03	0.26 ± 0.06	0.82 ± 0.12	0.86 ± 0.12	0.83 ± 0.11	0.85 ± 0.11	0.92 ± 0.23
Carmans River (Site A)	26-Aug-97	Sediment	1.56 ± 0.42	ND	0.09 ± 0.03	0.24 ± 0.05	0.21 ± 0.05	ND	0.34 ± 0.08	ND
Carmans River (Site B)			1.25 ± 0.32	0.05 ± 0.02	0.08 ± 0.03	0.26 ± 0.05	0.22 ± 0.05	0.19 ± 0.04	0.27 ± 0.06	ND
Swan Pond	26-Aug-97	Sediment	0.70 ± 0.21	ND	0.05 ± 0.02	0.16 ± 0.03	0.09 ± 0.03	0.12 ± 0.03	ND	ND
Flander's Bay (Site A)	29-Jul-97	Sediment	1.91 ± 0.63	ND	ND	0.17 ± 0.07	ND	ND	ND	ND
Flander's Bay (Site B)		Sediment	1.73 ± 0.39	0.02 ± 0.01	0.05 ± 0.02	0.16 ± 0.03	0.08 ± 0.02	0.16 ± 0.03	0.24 ± 0.04	0.27 ± 0.07

ND = Not Detected.

solved oxygen), anions (i.e., chlorides, sulfates, and nitrates), metals, and VOCs routinely during 1997.

A summary of water quality and metals analytical data for surface waters is given in Tables 7-10 and 7-11, respectively. Location HMn, which is downstream of the BNL STP, has characteristics very similar to the STP discharge. With the exception of pH, all water quality and metal parameters were typical of the STP discharge. Whereas the STP effluent is compared to SPDES effluent limits, concentrations in surface water samples are compared to the ambient water quality standard (AWQS). Comparison to the NYS AWQS for a Class C water system shows the concentration of iron, lead, mercury, and zinc to be slightly higher in the water samples collected at HMn. However, the AWQS is based upon the dissolved fraction whereas all analyses are total recoverable (i.e., acid digested). Due to the low AWQS, the detection limit is insufficient to evaluate samples against the AWQS. Beginning in 1999 surface water samples will be filtered prior to analysis to allow better comparison. The pH of the Peconic River, as measured downstream of the STP discharge, is frequently lower than the ambient water quality standard. Contributions of groundwater, natural decay products, such as humic acids, and storm water runoff, all of which have pH values typically less than 5.8, contribute to this. Location HQ, which is located at the site boundary, also had similar characteristics to the STP discharge. Again, the pH was typically lower than that recorded at the STP and HMn, most probably due to groundwater and storm water contributions. Iron and lead are present at station HQ at concentrations, which slightly exceed ambient water quality standards but are consistent with the off-site control location.

Locations HA, HB, HC, and HR are at various points along the Peconic River, off-site and downstream of BNL. Again, with the exception of pH, all water quality parameters are consistent with either the NYS AWQS, off-site control location, or with historical data. The low pH values recorded at the river stations may be attributed to the natural low pH of groundwater and storm water and by the contributions of natural decay products. All concentrations of metals, except iron and zinc, were within the AWQS and were consistent with the off-site control. Zinc was detected at HMn in May and HB in March at significantly higher concentrations than other locations. Both observations were single events, with all other values being much less than the standard. Iron was detected at all locations. Iron and zinc are naturally occurring elements and are present in sediments which make up the sample. As previously noted, beginning in 1999 river water samples will be filtered prior to acid preservation to obtain a better comparison to the AWQS. The occurrences are clearly isolated and do not represent a pattern of consistently high concentrations. All other metal parameters were consistent with historical data, and the background levels at the Carmans River station.

During 1997, all surface waters locations were analyzed for VOC contamination by the ES&HS Division Analytical Laboratory. With the exception of trace concentrations (i.e., less than 2 ug/L) of chloroform, TCA and DCA, no VOCs were detected above the Laboratory detection limit of 2 ug/L in samples collected from the Peconic or Carmans River stations. Chloroform was detected at Location HMn and is most likely present as a chlorination-by-product. The cessation of chlorination at the STP should eliminate future detections of this compound. TCA and DCA were detected at Location HR. Due to its location, and the absence of these compounds at stations closer to the BNL site, their presence is not attributable to BNL operations.

7.6.2 Peconic River Surveillance - Radiological Analyses

Radionuclides were measured in surface water samples collected from the Peconic River at seven locations: Station HMn, 790 meters downstream of the STP Outfall; Station HMs, a typically dry tributary of the Peconic River; Station HQ, 2.1 km downstream from the STP; Location HA and HB, 5 km downstream; Location HC, 7 km downstream; and Location HR in Riverhead, 21 km downstream from the STP Outfall. The Carmans River (Location HH) in North Shirley, was sampled as a control location not influenced by BNL liquid effluents. Sampling points along the Peconic River are identified in Figure 7-9. Routine samples at Location HMn were collected three times per week. Since February 1995, this location has been equipped with a Parshall flume al-

Table 7-10
BNL Site Environmental Report for Calendar Year 1997
Water Quality Data for Surface Water Samples
Collected Along the Peconic and Carmans Rivers

River	Sample Location ^(a)		pH SU	Conductivity umhos/cm	Temp. deg. C	Dissolved Oxygen mg/L	Chlorides mg/L	Sulfates mg/L	Nitrates as N mg/L
Peconic	HMn	N	160	159	160	155	4	4	4
		Min.	5.6	123	1.2	5.3	26.7	13.8	2.7
		Max.	6.9	250	25.8	17.7	39.8	16.7	5.2
		Avg.	NA	239	12.8	8.4	31.6	15.3	3.7
	HMs	N	4	4	4	2	4	4	4
		Min.	3.6	39	4.8	9.8	5.6	< 4.0	< 1.0
		Max.	3.9	95	11.9	12.9	44.3	25.3	3
		Avg.	NA	66	6.7	11.4	15.8	7.7	< 1.0
	HQ	N	80	80	80	74	4	4	4
		Min.	4.8	79	0.43	5.3	19.5	8.2	< 1.0
		Max.	7.6	315	23.8	18.5	30.3	11.9	1.3
		Avg.	NA	195	10.1	10.4	25.1	10.3	< 1.0
	HA	N	4	4	4	3	4	4	4
		Min.	4.8	53	3.6	6.1	6.9	< 4.0	< 1.0
		Max.	6.5	110	23.8	13.4	10.6	8.5	< 1.0
		Avg.	NA	73	11.7	9.3	7.9	4.8	< 1.0
	HB	N	4	4	4	4	4	4	4
		Min.	5.7	63	2.6	7.8	7.3	< 4.0	< 1.0
		Max.	6.9	73	24	11.1	10	8.6	< 1.0
		Avg.	NA	64	11.5	9.8	8.7	< 4.0	< 1.0
	HC	N	3	3	3	3	4	4	4
		Min.	6	65	3.4	7.4	9.7	< 4.0	< 1.0
		Max.	6.4	83	25.3	14.2	10.7	12	< 1.0
		Avg.	NA	76	11.6	10.9	10.3	5	< 1.0
	HR	N	4	4	4	4	4	4	4
		Min.	6.4	71	4	9.7	< 4.0	< 4.0	<1.0
		Max.	7.3	126	27.5	14.5	17.2	12.9	<1.0
		Avg.	NA	107	15.5	11.8	12.1	8.3	<1.0
Carmans	HH	N	4	4	4	4	4	4	4
		Min.	6.4	153	6	10.6	22.2	10.1	<1.0
		Max.	7.9	155	19.1	12.6	23.5	11.2	1.8
		Avg.	NA	154	13.3	11.7	23	10.7	1.1
NYS AWQS (b)			6.5 - 8.5	(c)	(c)	(c)	250	250	10
Typical MDL			NA	10	NA	NA	4	4	1

N: No. of samples

NA: Not Applicable

MDL: Minimum Detection Limit

(a): The Peconic and Carmans Rivers sample locations are shown on Figure 7-4.

(b): AWQS: Since there are no Class C Surface Water Ambient Water Quality Standards (AWQS) for these compounds, the AWQS for Ground Water is provided, if specified.

(c): No AWQS specified.

Table 7-11
BNL Site Environmental Report for Calendar Year 1997
Metals Concentration Data for Surface Water Samples
Collected Along the Peconic and Carmans Rivers

River	Sample Location ^(a)		Ag	Cd	Cr	Cu	Fe	Hg	Mn	Na	Pb	Zn
			(mg/L)									
Peconic	HMn	N	11	11	11	11	11	11	11	11	11	11
		Min.	< 0.025	<0.0005	<0.005	<0.05	< 0.075	<0.0002	<0.05	28.4	<0.002	<0.02
		Max.	<0.025	<0.0005	<0.005	< 0.05	0.53	0.0004	0.19	42.7	0.003	0.3
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.22	<0.0002	<0.05	33.6	<0.002	0.04
	HMs	N	5	5	5	5	5	5	5	5	5	5
		Min.	< 0.025	<0.0005	<0.005	<0.05	< 0.075	<0.0002	<0.05	3.3	<0.002	0.028
		Max.	<0.025	<0.0005	<0.005	< 0.05	2.3	<0.0002	< 0.05	30.3	0.003	0.04
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.65	<0.0002	<0.05	8.8	<0.002	0.033
	HQ	N	7	7	7	7	7	7	7	7	7	7
		Min.	< 0.025	<0.0005	<0.005	<0.05	0.11	< 0.0002	<0.05	23.4	<0.002	< 0.02
		Max.	< 0.025	< 0.0005	<0.005	< 0.05	0.35	< 0.0002	< 0.05	45	0.003	0.032
		Avg.	<0.025	<0.0005	<0.005	<0.05	0.2	< 0.0002	<0.05	31	<0.002	< 0.02
	HA	N	4	4	4	4	4	4	4	4	4	4
		Min.	< 0.025	< 0.0005	< 0.005	< 0.05	0.19	< 0.0002	< 0.05	5.1	< 0.002	< 0.02
		Max.	< 0.025	< 0.0005	< 0.005	< 0.05	2.6	< 0.0002	0.09	8.7	< 0.002	0.05
		Avg.	< 0.025	<0.0005	<0.005	<0.05	1.6	<0.0002	< 0.05	7.1	<0.002	0.02
	HB	N	4	4	4	4	4	4	4	4	4	4
		Min.	< 0.025	< 0.0005	< 0.005	< 0.05	0.54	< 0.0002	< 0.05	5.6	< 0.002	< 0.02
		Max.	< 0.025	< 0.0005	< 0.005	< 0.05	9.3	< 0.0002	0.13	8.1	< 0.002	0.19
		Avg.	< 0.025	<0.0005	<0.005	<0.05	4	<0.0002	0.08	7.8	<0.002	0.08
	HC	N	4	4	4	4	4	4	4	4	4	4
		Min.	< 0.025	< 0.0005	< 0.005	< 0.05	0.44	< 0.0002	< 0.05	5.9	< 0.002	< 0.02
		Max.	< 0.025	< 0.0005	< 0.005	< 0.05	6.7	< 0.0002	0.24	7.3	0.006	0.07
		Avg.	< 0.025	<0.0005	<0.005	<0.05	3.3	<0.0002	0.13	6.8	<0.002	0.03
	HR	N	4	4	4	4	4	4	4	4	4	4
		Min.	< 0.025	< 0.0005	< 0.005	< 0.05	0.34	< 0.0002	0.05	10.1	< 0.002	< 0.02
		Max.	< 0.025	< 0.0005	< 0.005	< 0.05	0.97	< 0.0002	0.07	16	< 0.002	0.041
		Avg.	< 0.025	<0.0005	<0.005	<0.05	0.56	<0.0002	0.07	12.2	<0.002	< 0.02
Carmans	HH	N	4	4	4	4	4	4	4	4	4	4
		Min.	< 0.025	< 0.0005	< 0.005	< 0.05	0.41	< 0.0002	< 0.05	10.4	< 0.002	< 0.02
		Max.	< 0.025	< 0.0005	< 0.005	< 0.05	0.5	< 0.0002	0.09	16.7	< 0.002	0.026
		Avg.	< 0.025	<0.0005	<0.005	<0.05	0.47	<0.0002	0.06	14.4	<0.002	< 0.02
NYSDEC SPDES Limit			0.015	(b)	(b)	0.15	0.37	0.0008	(b)	(b)	0.019	0.1
NYSDEC AWQS			0.0001	0.001	0.034	0.004	0.3	0.0000007	0.3	(b)	0.001	0.03
Typical MDL			0.025	0.0005	0.005	0.05	0.075	0.0002	0.05	1	0.002	0.02

N: No. of samples

AWQS: Ambient Water Quality Standard for Class C Surface Water

MDL: Minimum Detection Limit

(a): The Peconic and Carmans River sample locations are shown on Figure 7-4.

(b): There are no SPDES limits or AWQS specified for these compounds.

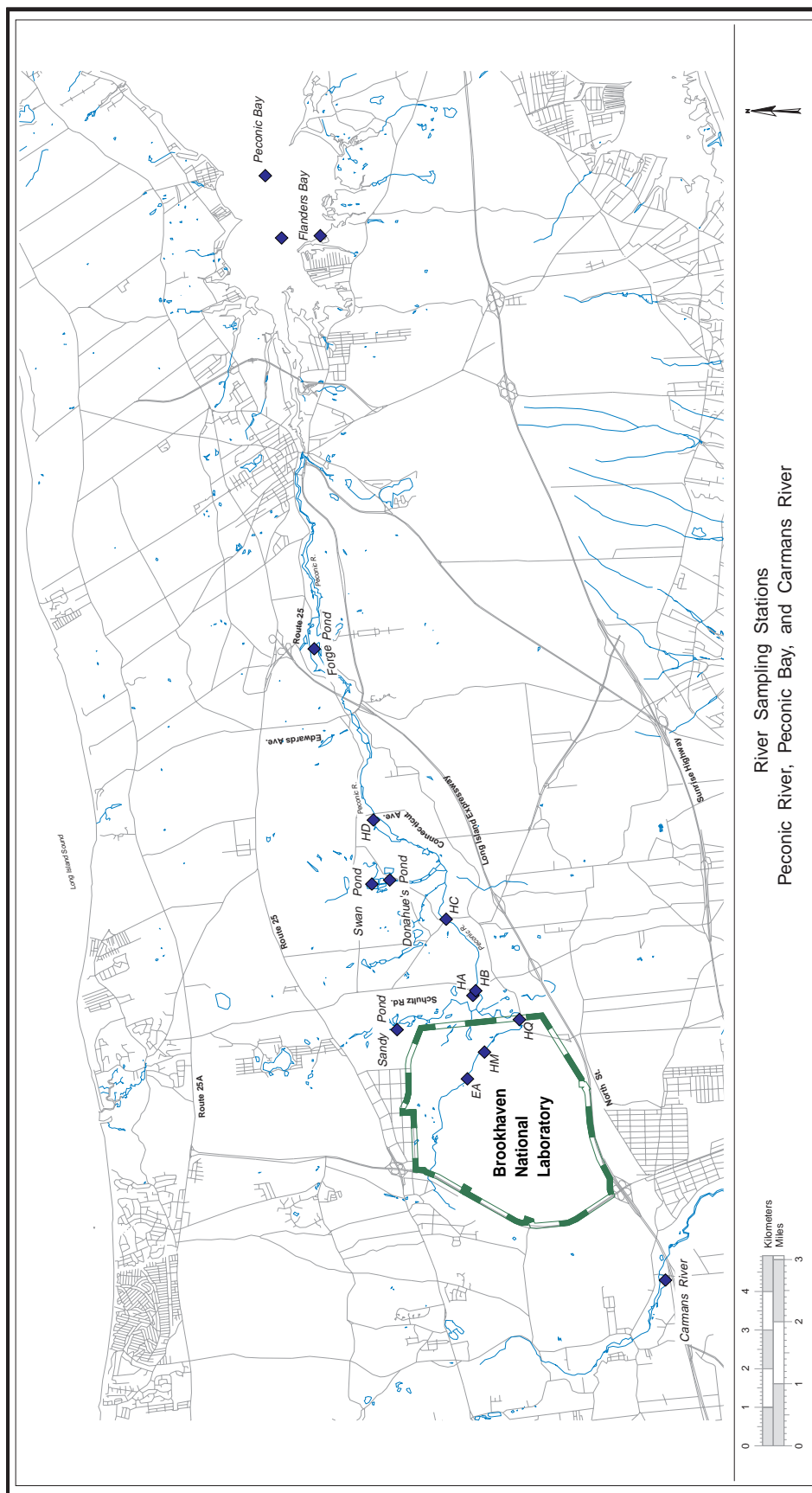


Figure 7-9.
 River Sampling Stations,
 Peconic River, Peconic Bay, and Carmans River

Table 7-12
BNL Site Environmental Report for Calendar Year 1997
Gross Activity and Tritium Analysis of the Peconic River

Sample Station	Geographic Location	Collect Date	Gross Alpha	Gross Beta	Tritium
				(pCi/L)	
HMn*	Peconic River, 0.7 km from STP On-Site	N	153	153	155
		Max.	13.3 ± 3.7	17.6 ±5.6	20,600 ± 832
		Avg.	1.4 ± 3.6	6.5 ± 6.7	1,158 ± 4,061
HQ*	Peconic River, BNL Site Boundary	N	79	79	82
		Max.	4.1 ± 2.3	12.9 ± 5.3	7,680 ± 543
		Avg.	0.7 ± 2.1	4.3 ± 5.4	968 ± 1,704
HMs	Peconic River Tributary On-Site	28-Jan-97	< 2.7	< 7.0	< 372
		7-Feb-97	< 3.1	< 7.3	< 375
		2-Apr-97	0.6 ± 0.3	< 1.7	< 372
		5-May-97	1.5 ± 0.9	6.7 ± 2.4	< 416
HA	Peconic River Off-Site	18-Mar-97	< 3.1	10.4 ± 5.3	< 333
		10-Jul-97	< 3.2	< 7.6	< 304
		9-Dec-97	< 1.2	< 4.8	< 336
HB	Peconic River Off-Site	18-Mar-97	< 3.1	9.6 ± 5.2	< 333
		10-Jul-97	3.3 ± 2.2	22.9 ± 5.4	< 304
		9-Dec-97	< 1.7	< 4.4	< 334
HC	Peconic River Off-Site	18-Mar-97	< 3.1	7.8 ± 5.1	< 333
		10-Jul-97	< 3.2	< 7.6	< 304
		9-Dec-97	< 1.2	< 4.8	< 335
HR	Peconic River, Riverhead	18-Mar-97	< 3.1	< 7.8	< 333
		10-Jul-97	< 3.2	< 7.6	< 304
		9-Dec-97	< 1.7	< 4.4	< 343
HH	Carmans River (Control Location)	18-Mar-97	< 3.1	< 7.8	< 333
		10-Jul-97	< 1.6	< 3.8	< 304
		9-Dec-97	< 1.2	< 4.8	< 335
SDWA Limit			15	50 (screening)	20,000

* Due to the large number of individual samples, the data for these locations have been summarized.

Third quarter samples for HA, HB, HC, HR, and HH invalidated due to analytical instrument malfunction.

N = Number of samples analyzed.

lowing flow proportional sampling and volume measurements to be made by an automated system. All other sites were “grab” sampled, either as flow allowed (in the case of HMs and HQ), or quarterly (HA, HB, HC, HH, and HR).

The radiological data generated from the analysis of Peconic River surface water sampling are summarized in Tables 7-12 and 7-13. Though occasionally detectable at levels around 11 pCi/L (0.4 Bq/L), average gross beta activity at Station HMn was below the minimum detection limit of approximately 7 pCi/L (0.3 Bq/L). The majority of gross alpha activity measurements were also below the detection limit.

Samples at Station HQ (located at the eastern site boundary) were collected much more frequently than in recent years due to increased flow of the Peconic there. Since the Peconic is a ground-water-fed river, elevated water table conditions in 1997 provided frequent flow at HQ. At least

Table 7-13
BNL Site Environmental Report for Calendar Year 1997
Gamma-Emitting Radionuclides and Sr-90 Analysis of Peconic River

Sample Station	Geographic Location	Collect Date	Be-7	Co-60	Cs-137	K-40	Na-22	Sr-90
			(pCi/L)					
HMn	Peconic River, 0.7 km from STP On-Site	31-Mar-97	ND	ND	0.84 ± 0.30	ND	ND	1.21 ± 0.07
		30-Jun-97	ND	ND	1.20 ± 0.22	3.48 ± 0.89	ND	NS
		30-Sep-97	ND	ND	2.17 ± 0.37	4.25 ± 0.92	ND	<0.95
		31-Dec-97	ND	0.05 ± 0.02	0.52 ± 0.10	4.18 ± 0.91	0.11 ± 0.04	<3.16
HMs	Peconic River, Tributary, On-Site	28-Jan-97	ND	ND	ND	ND	ND	0.83 ± 0.06
		7-Feb-97	ND	ND	ND	ND	ND	<0.17
		2-Apr-97	ND	ND	ND	ND	ND	<0.19
		5-May-97	ND	ND	ND	ND	ND	NS
HQ	Peconic River, BNL Site Boundary	31-Mar-97	0.55 ± 0.31	ND	0.61 ± 0.11	2.31 ± 0.64	0.15 ± 0.05	1.18 ± 0.07
		30-Jun-97	ND	ND	1.23 ± 0.22	3.16 ± 0.79	0.08 ± 0.05	NS
		31-Jul-97	ND	ND	2.65 ± 0.70	14.90 ± 7.18	ND	<3.14
HA	Peconic River Off-Site	18-Mar-97	ND	ND	0.29 ± 0.17	ND	ND	(a)
		10-Jul-97	ND	ND	0.33 ± 0.21	4.68 ± 3.14	ND	(a)
		25-Sep-97	ND	ND	ND	ND	ND	< 0.39
		10-Dec-97	ND	ND	ND	ND	ND	< 0.35
HB	Peconic River Off-Site	18-Mar-97	ND	ND	ND	ND	ND	(a)
		10-Jul-97	ND	ND	ND	ND	ND	< 1.0
		25-Sep-97	ND	ND	ND	2.12 ± 2.04	ND	< 0.35
		9-Dec-97	ND	ND	ND	ND	ND	< 0.29
HC	Peconic River Off-Site	18-Mar-97	ND	ND	ND	ND	ND	(a)
		10-Jul-97	ND	ND	ND	2.64 ± 2.37	ND	< 1.0
		18-Sep-97	ND	ND	ND	2.72 ± 2.18	ND	NS
		9-Dec-97	ND	ND	ND	ND	ND	< 0.23
HR	Peconic River, Riverhead	18-Mar-97	ND	ND	ND	ND	ND	(a)
		10-Jul-97	ND	ND	ND	ND	ND	(a)
		18-Sep-97	ND	ND	ND	ND	ND	NS
		9-Dec-97	ND	ND	ND	ND	ND	< 0.70
HH	Carmans River (Control Location)	18-Mar-97	ND	ND	ND	3.28 ± 2.46	ND	(a)
		10-Jul-97	ND	ND	ND	3.80 ± 3.45	ND	< 1.0
		18-Sep-97	ND	ND	ND	ND	ND	NS
		9-Dec-97	ND	ND	ND	ND	ND	< 0.39
DOE Order 5400.5 DCG			1,000,000	5,000	3,000	7,000	10,000	8(b)
SDWA Limit			40,000	200	120	280	400	8

Notes:

- Values reported with 2σ (95%) confidence interval.
 - ND = Not Detected.
 - NS = Not sampled for this analyte.
 - DCG = Derived Concentration Guide, the concentration of a radionuclide which would produce an individual dose of 100 mrem if ingested at a rate of 2 liters per day for one year.
- (a) Sample result invalidated during QA review.
(b) Safe Drinking Water Act limit shown.

80 samples were collected at HQ for gross alpha and beta activity and tritium analysis. Annual average gross activity values were below typical minimum detection limits. Tritium was detectable at HQ sporadically throughout the year. The highest instantaneous concentration of 7,680 pCi/L (284 Bq/L) was observed in July following the STP tritium spike (Section 6.2.1.2 for details); the annual average concentration at this station was less than 1,000 pCi/L (37 Bq/L). Tritium was not detected in any quarterly Peconic River samples collected beyond the BNL site boundary.

Cesium-137 continues to be detectable at very low levels (0.5 to 2 pCi/L [0.02 to 0.07 Bq/L]) at HMn and HQ as it continues to leach out of the STP sand filter beds (see Section 6.2.1.1 for discussion). Cesium-137 levels observed at these stations are consistent with those measured at the STP Outfall. These levels are very small fractions of the DOE Order 5400.5 DCG for cesium-137 which is 3,000 pCi/L (111 Bq/L). Cesium was not detected at any off-site sampling location beyond Station HA.

In Peconic River samples collected at Riverhead (Location HR), gross alpha and gross beta activity was less than detection limits throughout the year. No man-made gamma-emitting radionuclides were detected.

7.7 Aquatic Biological Surveillance

7.7.1 Radiological Analysis of Local Fish

The Laboratory, in collaboration with the NYSDEC Fisheries Division, maintains an ongoing program for the collection of fish from the Peconic River and surrounding fresh water bodies. The program was significantly expanded in 1996, and repeated in 1997, to include more sampling locations, types of fish caught, and analyses performed. Fish samples were collected from on-site portions of the Peconic River, Donahue's Pond, Forge Pond, Swan Pond, and also from Massapequa Pond, Smith Pond (Roosevelt), Meadow Lake, Searington Pond and the Carmans River (Figure 7-9) which are not connected to the Peconic River system and are, therefore, used as control locations to indicate environmental background. Brown Bullhead (*Ictalurus nebulosus*), Golden Shiner (*Notemigonus crysoleucas*), Chain Pickerel (*Esox niger*), Large Mouth Bass (*Micropterus salmoides*), Blue Gill (*Lepomis macrochirus*), Eel, Pumpkinseed (*Lepomis gibbosus*), Gizzard Shad, Black Crappie, Creek Chubsucker (*Erimyzon oblongus*), and White and Yellow Perch (*Perca flavescens*) species were collected and analyzed by gamma spectroscopy. Specific information on the sampling point, species collected, and analytical results are presented in Table 7-14.

Analyses were performed separately on the flesh and skin, the viscera and bones, and the whole fish. Segregating the analyses in this way provides important information regarding the localization of radionuclides in certain parts of the fish, and allows more realistic dose calculations to be performed. For example, some radionuclides such as strontium-90 may localize in bone due to their chemical characteristics. However, bones are usually discarded when fish are eaten, eliminating a significant source of radionuclides and reducing the potential dose to people.

The only anthropogenic radionuclide found in these samples was cesium-137; it is detectable throughout the environment of the Northern Hemisphere as a result of past global fallout. This is evident when examining results from the control location of Swan Pond, where cesium-137 levels in fish flesh are comparable to those of fish taken from Peconic River-fed water bodies such as Donahue's Pond (Figure 7-10).

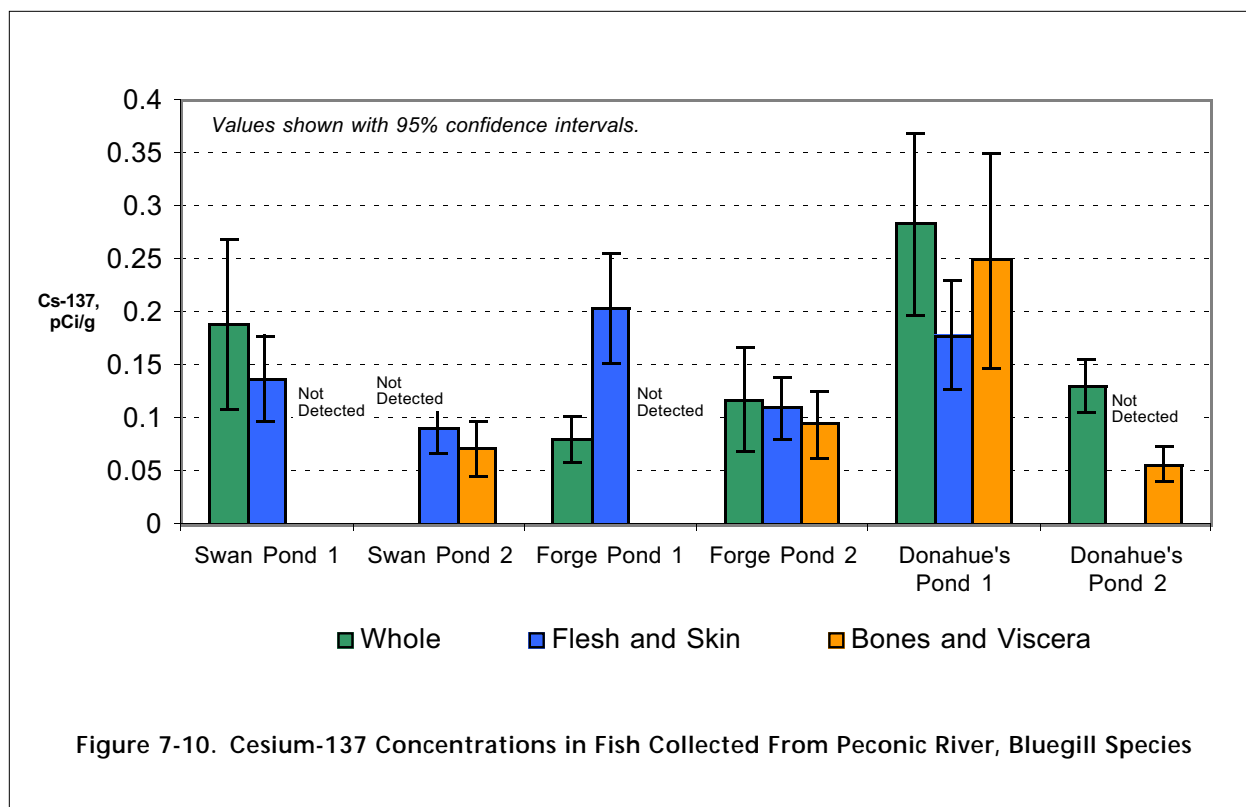
Though it is clear that BNL operations have contributed to radionuclide levels in the Peconic River system, most of these radionuclides (except tritium) were released between the late 1950s and early 1970s. In light of control data, present day cesium-137 concentrations in fish in the Peconic River system appear to be within the range of variability seen in local waters which receive no discharges from BNL. This is feasible when considering the lack of significant new discharges of cesium-137, time elapsed for radioactive decay, and sediment turnover which segregates old contaminants below the riverbed.

Table 7-14
BNL Site Environmental Report for Calendar Year 1997
Radiological Analysis of Fish

Fish - Sample Type	Sample Date	K-40	Cs-137
		pCi/g.wet	
Massapequa			
Carp - whole	11-Jul-97	2.85 ± 0.53	ND
Carp - flesh/skin		ND	ND
Carp - bones/viscera		2.65 ± 1.06	ND
Smith Pond (Roosevelt)			
Eel - whole	12-Aug-97	2.48 ± 0.52	ND
Pumpkinseed - whole		1.56 ± 0.29	0.01 ± 0.01
Pumpkinseed - flesh/skin		4.15 ±1.25	ND
Pumpkinseed - bones/viscera		3.88 ± 2.49	ND
Meadow Lake			
Gizzard shad - whole	5-June-97	2.31 ± 0.50	ND
Gizzard shad - flesh/skin		7.15 ± 2.05	ND
Gizzard shad - bones/viscera		3.12 ± 0.68	ND
Gizzard shad - whole		1.80 ± 0.32	0.01 ± 0.01
Gizzard shad - whole		2.19 ± 0.40	0.01 ± 0.01
Gizzard shad - flesh/skin		4.16 ± 1.18	ND
Gizzard shad - bones/viscera		1.83 ± 0.58	ND
Gizzard shad - whole		1.56 ± 0.36	0.02 ± 0.01
White perch - whole		1.86 ± 0.43	ND
White perch - whole		1.36 ± 0.42	ND
Searington Pond			
Black crappie - whole	15-Jul-97	12.91 ± 4.48	ND
Goldfish - flesh/skin		2.33 ± 0.54	ND
Goldfish - bones/viscera		1.40 ± 0.62	ND
Peconic River - Schultz Road			
Pumpkinseed - whole	5-May-97	2.14 ± 1.32	0.22 ± 0.12
Golden shiner - whole		4.88 ± 2.59	0.70 ± 0.30
Donahue's Pond			
Bluegill - whole	13-May-97	1.98 ± 0.36	0.13 ± 0.03
Bluegill - flesh/skin		6.40 ± 2.15	ND
Bluegill - bones/viscera		0.92 ± 0.19	0.06 ± 0.02
Bluegill - whole		3.46 ± 1.14	0.28 ± 0.09
Bluegill - flesh/skin		3.83 ± 0.86	0.18 ± 0.05
Bluegill - bones/viscera		ND	0.25 ± 0.10
Chain pickerel - whole		4.86 ± 1.74	0.46 ± 0.16
Largemouth bass - whole		2.12 ± 0.41	0.29 ± 0.06
Frog - whole		ND	ND
Forge Pond			
Bluegill - whole	30-Apr-97	2.93 ± 0.54	0.08 ± 0.02
Bluegill - flesh/skin		4.66 ± 0.92	0.20 ± 0.05
Bluegill - bones/viscera		3.32 ± 1.99	ND
Bluegill - whole		2.47 ± 0.62	0.11 ± 0.03
Golden shiner - whole		ND	ND
Pumpkinseed - whole		2.77 ± 0.97	0.11 ± 0.07
Pumpkinseed - flesh/skin		2.04 ± 0.52	0.14 ± 0.04
Pumpkinseed - bones/viscera		2.89 ± 2.36	0.47 ± 0.29
Bluegill - whole		2.57 ± 0.81	0.12 ± 0.05
Bluegill - flesh/skin		2.63 ± 0.59	0.11 ± 0.03
Bluegill - bones/viscera		2.21 ± 0.45	0.09 ± 0.03

Notes

1. All results reported with 2σ (95%) confidence interval.
2. ND = Not Detected.



7.7.2 Radiological Analysis of Shellfish

In 1997, clams, mussels, and sediment samples were collected from Flanders Bay and Indian Point in Riverhead to determine whether past BNL discharges to the Peconic River system have made a measurable contribution to shellfish radionuclide uptake. Similar samples were also collected from Lloyd Harbor, a background location not influenced by the Peconic River system. All samples were analyzed for gamma-emitting radionuclides (Table 7-15). Only naturally-occurring radionuclides such as potassium-40 were observed. Neither cesium-137 nor any other man-made radionuclides were detected in any of the samples. These data are consistent with the shellfish analysis results reported in the 1996 BNL Site Environmental Report indicating that there are no detectable Laboratory-produced radionuclides present in shellfish collected from Flanders Bay.

7.8 Chronic Toxicity Tests

The Chronic Toxicity Testing program initiated in 1993 for the STP effluent was continued after the STP upgrades were completed in September 1997. Samples were collected in December and submitted to a contract laboratory for testing. As required by BNL's SPDES permit, this program consists of performing seven-day, Tier II Chronic Toxicity Tests of the BNL STP effluent. Two fresh water organisms, water fleas (*Ceriodaphnia dubia*) and fathead minnows (*Pimphales promelas*), are used for testing. The animals, in replicates of ten, were exposed to varying concentrations of the STP effluent (i.e., 100%, 50%, 25%, 12.5%, and 6.25%) for seven days. The size of fish and/or rate of reproduction for the water flea is measured and compared to untreated animals. The results were transmitted to the NYSDEC for review in January 1998.

The data show there was no acute toxicity for either organism, nor were there any chronic effects such as changes in the rate of reproduction for the water flea. The growth rate for the minnows raised in the 25% sample was lower than the control group. A "No Observable Effect Concentration" of 12.5% was reported for this organism. Toxicity testing will continue through 1998.

Table 7-15
Site Environmental Report for Calendar Year 1997
Radiological Analysis of Local Mussels and Clams

Sample Location	Sample Date	Sample Type	K-40 (pCi/g, wet)	Cs-137
Flander's Bay - Site A	29-Jul-97	Clams	1.24 ± 0.30	ND
Flander's Bay - Site B		Clams	0.96 ± 0.16	ND
Flander's Bay - Site C		Clams	1.03 ± 0.17	ND
Flander's Bay - Site C		Conch	2.34 ± 0.46	
Flander's Bay - Site D		Clams	0.89 ± 0.19	ND
Flander's Bay - Site E		Clams	1.03 ± 0.19	ND
Indian Point - Site A	30-Jul-97	Mussels	1.01 ± 0.18	ND
Indian Point - Site B		Mussels	1.00 ± 0.29	ND
Lloyd Harbor - Site A	4-Aug-97	Clams	1.13 ± 0.19	ND
Lloyd Harbor - Site B		Clams	1.83 ± 0.47	ND
Lloyd Harbor - Site C		Clams	1.73 ± 0.45	ND
Lloyd Harbor - Site D		Clams	1.23 ± 0.22	ND

ND = Not Detected.

7.9 OU V Remedial Investigation Fish Tissue Bioaccumulation Study

The Operable Unit V draft Remedial Investigation Report concluded that sediments in the Peconic River contain elevated concentrations of mercury and silver. To better determine the potential for bioaccumulation of these sediment contaminants, a more rigorous study of concentrations in fish obtained from the Peconic River, both on the site and off, was conducted. This section summarizes the results of the chemical and radiological analyses of the fish samples. Ninety-seven fish samples were analyzed for mercury and other inorganic analytes (cadmium, copper, lead, nickel, and silver), pesticides (DDT and its derivatives, endosulfan, and chlordane), and PCB aroclor-1254 (Tables 7-16 and 7-17). Thirteen composite samples were also analyzed for radionuclides (Table 7-18). Locations of sampling stations are given in Figures 7-11 through 7-13.

Cadmium was detected in most of the fish samples. The highest concentrations of cadmium were detected in pickerel at PR-29 near the STP discharge with concentrations of 0.14 mg/kg to 0.21 mg/kg. Average concentrations in predator fish (i.e., bass, pickerel, and pumpkinseed) at on-site stations PR-29 (0.16 mg/kg) and PR-30 (0.10 mg/kg) were significantly higher than the Sandy Pond reference fish (0.04 mg/kg at PR-32). Average concentrations in bottom feeders at PR-29 (0.10 mg/kg), PR-30 (0.11 mg/kg), and PR-31 (0.07 mg/kg) were significantly higher than the reference fish (0.02 mg/kg). Cadmium was not detected in the surface water samples. Sediment on-site at PR-30 and PR-31 contained detectable levels of cadmium (1.29 mg/kg and 1.84 mg/kg, respectively).

Copper was detected in all fish samples, the highest concentration in the only brown bullhead collected at PR-29. Average predator fish concentrations ranged from 1.70 mg/kg at PR-35 (Donahues Pond) to 3.90 mg/kg at PR-29. None were significantly higher than the average predator fish concentration at the reference station (2.45 mg/kg). Average bottom feeder concentrations at on-site stations PR-29 (4.38 mg/kg) and PR-30 (3.87 mg/kg) were significantly higher

than the reference fish (2.53 mg/kg). Copper was detected in the on-site surface water samples from PR-29 (47.8 ug/L), PR-30 (36.3 ug/L), and PR-31 (17.2 ug/L), but in none of the off-site surface water samples. The sediment concentrations ranged from 0.69 mg/kg to 94.37 mg/kg.

Lead was detected in all fish samples, the highest concentration in a largemouth bass collected from the reference location PR-32 at Sandy Pond (1.15 mg/kg). The highest average predator fish and bottom feeder concentrations were at PR-32 (0.59 mg/kg and 0.45 mg/kg, respectively). Lead was not detected in the surface water samples, and was only detected in two sediment samples. Both locations were on-site: PR-30 (12.6 mg/kg) and PR-31 (19 mg/kg).

Mercury was detected in all fish samples. The highest level of mercury was detected in a pumpkinseed collected at on-site location PR-31 (1.26 mg/kg). The average predator fish concentration at PR-29 (0.62 mg/kg) was higher than the reference fish (0.22 mg/kg). The average bottom feeder concentrations at PR-29 (0.60 mg/kg) and PR-30 (0.33 mg/kg) were greater than the reference fish (0.14 mg/kg). Mercury was detected in surface water samples from PR-29 (0.25 ug/L) and PR-30 (0.24 ug/L) and in sediments from PR-29 (0.14 mg/kg), PR-30 (3.08 mg/kg), PR-31 (1.25 mg/kg), and PR-33 (0.47 mg/kg).

Nickel was detected in all fish samples; the highest levels were in a pickerel from PR-33 (0.56 mg/kg) and a brown bullhead from the reference area PR-32 (0.31 mg/kg). The average predator fish concentrations ranged from 0.10 mg/kg at PR-34 to 0.16 mg/kg at PR-33. None were significantly higher than the reference fish (0.13 mg/kg). The average bottom feeder concentrations ranged from 0.05 mg/kg at PR-36 to 0.20 mg/kg at PR-34. None were significantly higher than the reference fish (0.15 mg/kg).

Silver was detected in most of the bottom feeders and more than half of the predator fish. The highest concentrations were in brown bullheads from on-site locations PR-29 (0.39 mg/kg), PR-30 (0.23 mg/kg), and PR-31 (0.23 mg/kg). The average predator concentrations at PR-29 (0.08 mg/kg), PR-30 (0.07 mg/kg), and PR-31 (0.06 mg/kg) were significantly higher than that in the reference fish (0.01 mg/kg). The average bottom feeder fish concentrations at PR-29 (0.16 mg/kg), PR-30 (0.12 mg/kg), and PR-31 (0.13 mg/kg) were significantly higher than in the reference fish (0.01 mg/kg). Silver was detected in only one surface water sample (5.6 ug/L at PR-30), but was detected in four sediment samples: 0.11 mg/kg at PR-29, 0.03 mg/kg at PR-30, 0.04 mg/kg at PR-31, and 0.01 mg/kg at PR-33.

DDT was detected in only two fish samples. The highest concentration of DDT was detected in a pumpkinseed collected at on-site station PR-31, and the other was in a pickerel collected on-site at PR-29. DDT was not detected in the surface water nor sediment samples (except at PR-36).

DDE was detected in most of the fish samples. Nine fish did not have detectable levels of DDE, seven of which were collected on the BNL site at PR-29, PR-30, and PR-31. The highest concentration was detected in largemouth bass at PR-35 at Swan Pond (the second reference location) having a concentration of 136 ug/kg. Average predator fish concentrations ranged from 87.6 ug/kg at PR-35 (Swan Pond) to 8.5 ug/kg at PR-34 (Manor Road). Average bottom feeder concentrations were highest for brown bullheads at PR-29 (near the STP), PR-31 (North Street), and PR-37 (Forge Pond) with values of 50.2 ug/kg, 51.02 ug/kg, and 50.85 ug/kg, respectively. DDE was detected in two on-site and two off-site sediment samples: on-site at 4.83 ug/kg at PR-30 and 6.61 ug/kg at PR-31, and off-site at 7.24 ug/kg at PR-33 and 12.94 ug/kg at PR-36.

DDD was detected in most of the fish samples. Twenty-eight of the thirty-six fish collected on the BNL site had non-detectable levels of DDD. Most off-site fish had detectable levels of DDD. The highest concentrations were detected in two brown bullheads: 76.9 ug/kg at PR-31 (North Street) and 70.3 ug/kg at PR-37 (Forge Pond). Average predator fish concentrations ranged from 33.13 ug/kg at PR-35 (Swan Pond) to non-detect at PR-29 (near the STP). Average bottom feeder fish concentrations ranged from 30.88 ug/kg at PR-36 (Donahues Pond) to non-detect at PR-29 (near the STP). DDD was found in most sediment samples. It was not detected at either PR-29 (near the STP) or PR-37 (Forge Pond). The highest concentration was 14.90 ug/kg at PR-33 (Schultz Road). DDD was not detected in any surface water samples.

Alpha-chlordane was detected in fourteen of the thirty-six samples collected on the BNL site. No off-site fish contained detectable levels of alpha-chlordane. The highest concentration was 32.5 ug/kg in a brown bullhead collected at PR-29 (near the STP). It was detected in two sediment samples (4.43 ug/kg at PR-30 and 3.43 ug/kg at PR-31), but was not detected in surface water samples.

Aroclor-1254, a PCB, was detected in most of the fish collected on the BNL site and in only one fish collected off the BNL site (423 ug/kg at PR-34 at Manor Road). The highest concentrations were detected in bottom feeders (creek chubsuckers and brown bullheads) collected at PR-29. Aroclor-1254 was not detected in any surface water or sediment samples collected during this study, though the previous Remedial Investigation sampling detected Aroclor-1254.

Gamma-chlordane, chlordane, endosulfan one, and endosulfan two were not detected in any fish samples.

Radiological analysis consisted of measurements for gamma-emitting radionuclides and strontium-90. Analysis for tritium was not performed since it does not tend to bioaccumulate, but, instead, is quickly eliminated from the body. Radionuclide analysis was usually performed on composite fish samples because of the analytical technique mass requirements. Station PR-34 at Manor Road did not have sufficient fish for radionuclide analysis. -Strontium-90 was detected in most fish samples ranging from an average of 3.16 pCi/g (0.12 Bq/g) at PR-32 (Sandy Pond) to non-detect at PR-29 (near the STP) and PR-33 (Schultz Road). Cesium-137 was detected in all fish samples ranging from an average of 1.79 pCi/g (0.07 Bq/g) at PR-29 (near the STP) to an average of 0.58 pCi/g (0.02 Bq/g) at PR-32 (Sandy Pond). No other radionuclides were detected in fish samples.

In sediment, cesium-137 was detected in most samples ranging from 9.63 pCi/g (0.36 Bq/g) at PR-31 (North Street) to 0.07 pCi/g (3 mBq/g) at PR-34 (Manor Road); it was not detected at PR-35 (Swan Pond). Radium-226 levels ranged from 1.88 pCi/g (0.07 Bq/g) at PR-33 (Schultz Road) to non-detect at PR-35 (Sandy Pond). However, the radium-226 content was determined by gamma spectroscopy, which tends to overestimate radium-226 concentrations. Americium-241 was only detected in the two furthest upstream on-site samples and cobalt-60 was only detected at on-site location PR-30 (east of the firebreak) at 0.19 pCi/g (7 mBq/g).

Table 7-16
BNL Site Environmental Report for Calendar Year 1997
OU V Fish Tissue Bioaccumulation Data, Metals

Analyte	Matrix		Peconic River Sampling Stations								
			PR-29	PR-30	PR-31	PR-32	PR-33	PR-34	PR-35	PR-36	PR-37
							(mg/kg)				
Cadmium	Surface Water		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment		ND	1.29	1.84	ND	ND	ND	ND	ND	ND
	Predator Fish	Avg.	0.16	0.10	0.07	0.04	0.04	0.04	0.01	0.01	0.01
		Max.	0.21	0.13	0.12	0.07	0.06	0.07	0.02	0.02	0.02
	Bottm Feeder Fish		Avg.	0.10	0.11	0.07	0.02	NA	0.04	NA	0.01
			Max.	0.15	0.18	0.20	0.02	---	0.04	---	0.01
	Surface Water		47.8	36.3	17.2	ND	ND	ND	ND	ND	ND
	Sediment		14.56	94.37	80.91	0.69	4.10	2.66	1.35	3.31	1.23
Copper	Predator Fish		Avg.	3.88	3.31	2.35	2.45	2.23	3.45	1.70	1.45
			Max.	5.42	3.96	3.78	3.54	3.53	5.51	1.89	1.61
	Bottm Feeder Fish		Avg.	4.38	3.87	3.5	2.53	NA	4.73	NA	2.11
			Max.	8.49	6.06	4.19	2.9	---	6.77	---	3.01
Lead	Surface Water		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment		ND	12.60	19	ND	ND	ND	ND	ND	ND
	Predator Fish	Avg.	0.18	0.23	0.33	0.59	0.34	0.22	0.12	0.25	0.77
		Max.	0.19	0.38	0.64	1.15	0.92	0.30	0.20	0.48	0.08
	Bottm Feeder Fish		Avg.	0.14	0.18	0.24	0.45	NA	0.13	NA	0.44
			Max.	0.23	0.22	0.32	0.65	---	0.13	---	0.97
	Surface Water		0.25	0.24	ND	ND	ND	ND	ND	ND	ND
	Sediment		0.14	3.08	1.25	ND	0.47	ND	ND	ND	ND
Mercury	Predator Fish		Avg.	0.62	0.53	0.42	0.22	0.52	0.33	0.14	0.43
			Max.	0.75	0.73	1.26	0.36	0.91	0.34	0.23	0.82
	Bottm Feeder Fish		Avg.	0.60	0.33	0.28	0.14	NA	0.32	NA	0.16
			Max.	0.69	0.66	0.64	0.24	---	0.34	---	0.20
Nickel	Surface Water		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment		2.09	10.68	5.86	ND	ND	ND	ND	ND	ND
	Predator Fish	Avg.	0.11	0.13	0.11	0.13	0.16	0.10	0.11	0.13	0.14
		Max.	0.16	0.16	0.13	0.22	0.56	0.10	0.16	0.17	0.23
	Bottm Feeder Fish		Avg.	0.11	0.10	0.11	0.15	NA	0.20	NA	0.05
			Max.	0.18	0.13	0.16	0.31	---	0.27	---	0.09
	Surface Water		ND	5.6	ND	ND	ND	ND	ND	ND	ND
	Sediment		0.11	0.03	0.04	0.01	ND	0.01	ND	0.02	0.01
Silver	Predator Fish		Avg.	0.08	0.07	0.06	0.01	0.02	0.01	0.01	0.01
			Max.	0.08	0.22	0.28	0.01	0.04	0.01	0.01	0.01
	Bottm Feeder Fish		Avg.	0.16	0.12	0.13	0.01	NA	0.02	NA	0.03
			Max.	0.39	0.23	0.23	0.01	---	0.02	---	0.04

ND = Not Detected

NA = Parameter not analyzed for at this location.

Notes:

1. All concentration represent wet weight of matrix
2. Station locations shown in Figures 7-11 to 7-13.
3. Station PR-32 is a control sampling location at Sandy Pond.

Table 7-17
BNL Site Environmental Report for Calendar Year 1997
OU V Fish Tissue Bioaccumulation Data, Pesticides and PCBs

Analyte	Matrix	Units		Peconic River Sampling Stations								
				PR-29	PR-30	PR-31	PR-32	PR-33	PR-34	PR-35	PR-36	PR-37
DDT	Surface Water	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment	ug/kg		ND	ND	ND	ND	ND	ND	ND	6.61	ND
	Predator Fish	ug/kg	Avg.	5.11	ND	7.93	ND	ND	ND	ND	ND	ND
		ug/kg	Max.	5.57	---	22.60	---	---	---	---	---	---
	Bottm Feeder Fish	ug/kg	Avg.	ND	ND	ND	ND	NA	ND	ND	ND	ND
		ug/kg	Max.	---	---	---	---	---	---	---	---	---
DDE	Surface Water	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment	ug/kg		ND	4.83	6.61	ND	7.24	ND	ND	12.94	ND
	Predator Fish	ug/kg	Avg.	15.85	14.09	33.41	24.73	27.82	8.50	87.61	31.36	42.71
		ug/kg	Max.	21.90	26.00	75.20	64.20	52.20	12.00	136.00	72.20	75.20
	Bottm Feeder Fish	ug/kg	Avg.	23.35	34.00	51.02	35.40	NA	20.9	NA	44.58	50.85
		ug/kg	Max.	50.20	51.10	93.50	43.30	---	27.60	---	59.80	71.40
DDD	Surface Water	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	
	Sediment	ug/kg		ND	7.92	10.46	4.30	14.9	7.24	8.43	3.72	ND
	Predator Fish	ug/kg	Avg.	ND	5.67	28.09	21.13	21.25	5.63	33.13	12.00	17.24
		ug/kg	Max.	---	6.00	142.0	100.0	68.90	6.26	38.70	23.10	30.70
	Bottm Feeder Fish	ug/kg	Avg.	ND	9.97	28.46	24.06	NA	24.20	NA	30.88	44.9
		ug/kg	Max.	---	44.80	76.90	40.10	---	32.20	---	37.70	70.30
Alpha-chlordan												
	Surface Water	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment	ug/kg		ND	4.43	3.43	ND	ND	ND	ND	ND	ND
	Predator Fish	ug/kg	Avg.	10.4	7.64	ND	6.11	ND	ND	ND	ND	ND
		ug/kg	Max.	13.80	13.50	---	10.00	---	---	---	---	---
	Bottm Feeder Fish	ug/kg	Avg.	10.06	8.34	7.50	ND	NA	ND	NA	ND	ND
		ug/kg	Max.	32.50	13.90	17.20	---	---	---	---	---	---
Aroclor-1254												
	Surface Water	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Predator Fish	ug/kg	Avg.	2009	1793	1584	ND	ND	262	ND	ND	ND
		ug/kg	Max.	3020	2540	4800	---	---	423	---	---	---
	Bottm Feeder Fish	ug/kg	Avg.	3393	1654	505	ND	NA	ND	NA	ND	ND
		ug/kg	Max.	4260	3510	2050	---	---	---	---	---	---

Notes:

ND = Not Detected

NA = Parameter not analyzed for at this location.

1. All concentration represent wet weight of matrix

2. Station locations shown in Figures 7-11 to 7-13.

3. Station PR-32 is a control sampling location at Sandy Pond.

Table 7-18
BNL Site Environmental Report for Calendar Year 1997
OU V Fish Tissue Bioaccumulation Data, Radionuclides

Analyte	Matrix	Units	Peconic River Sampling Stations									
				PR-29	PR-30	PR-31	PR-32	PR-33	PR-34	PR-35	PR-36	PR-37
Cs-137	Surface Water	pCi/L		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment	pCi/g	0.23		6.96	9.63	0.11	8.15	0.07	ND	0.12	0.18
	Fish	pCi/g	Avg.	1.79	1.60	1.07	0.58	1.66	NA	0.52	1.27	0.76
			Max.	1.88	1.6	1.07	0.63	1.66	---	0.66	1.42	0.97
Am-241	Surface Water	pCi/L		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment	pCi/g		0.11	0.96	ND	ND	ND	ND	ND	ND	ND
	Fish	pCi/g	Avg.	ND	ND	ND	ND	ND	ND	ND	ND	ND
			Max.	---	---	---	---	---	---	---	---	---
Co-60	Surface Water	pCi/L		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment	pCi/g		ND	0.19	ND	ND	ND	ND	ND	ND	ND
	Fish	pCi/g	Avg.	ND	ND	ND	ND	ND	ND	ND	ND	ND
			Max.	---	---	---	---	---	---	---	---	---
Ra-226	Surface Water	pCi/L		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment	pCi/g		0.35	0.80	0.85	ND	1.88	0.33	0.24	0.19	1.09
	Fish	pCi/g	Avg.	ND	ND	ND	ND	ND	NA	ND	ND	ND
			Max.	---	---	---	---	---	---	---	---	---
Sr-90	Surface Water	pCi/L		ND	ND	ND	ND	ND	ND	ND	ND	ND
	Sediment	pCi/g		ND	ND	ND	ND	0.43	ND	ND	ND	ND
	Fish	pCi/g	Avg.	ND	0.38	0.42	3.18	ND	NA	0.36	1.21	0.48
			Max.	---	0.38	0.42	4.31	---	---	0.40	1.22	0.59

ND = Not Detected

NA = Parameter not analyzed for at this location.

Notes:

1. All concentration represent wet weight of matrix
2. Station locations shown in Figures 7-11 to 7-13.
3. Station PR-32 is a control sampling location at Sandy Pond.

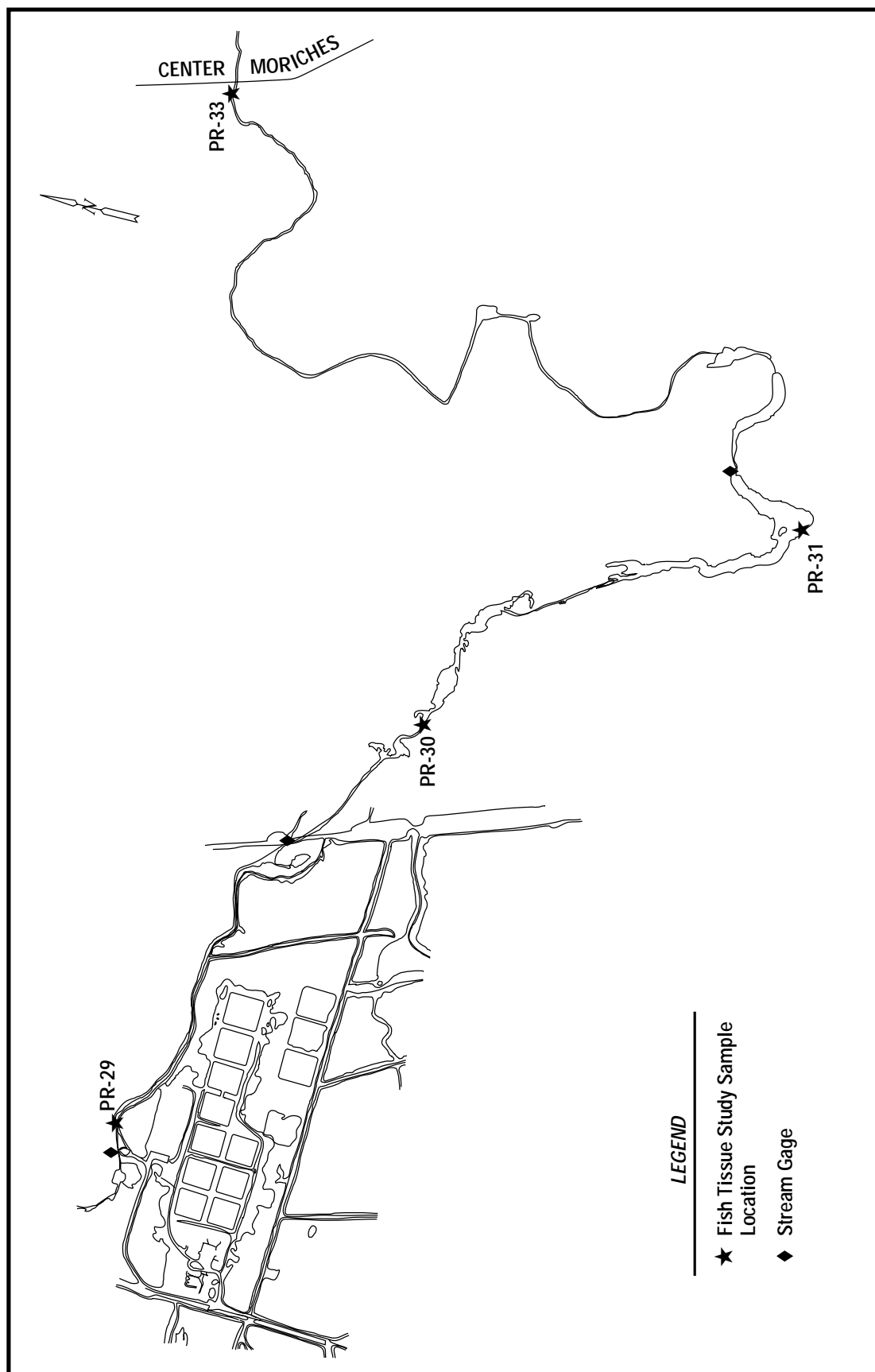


Figure 7-11. Fish Tissue Bioaccumulation Study

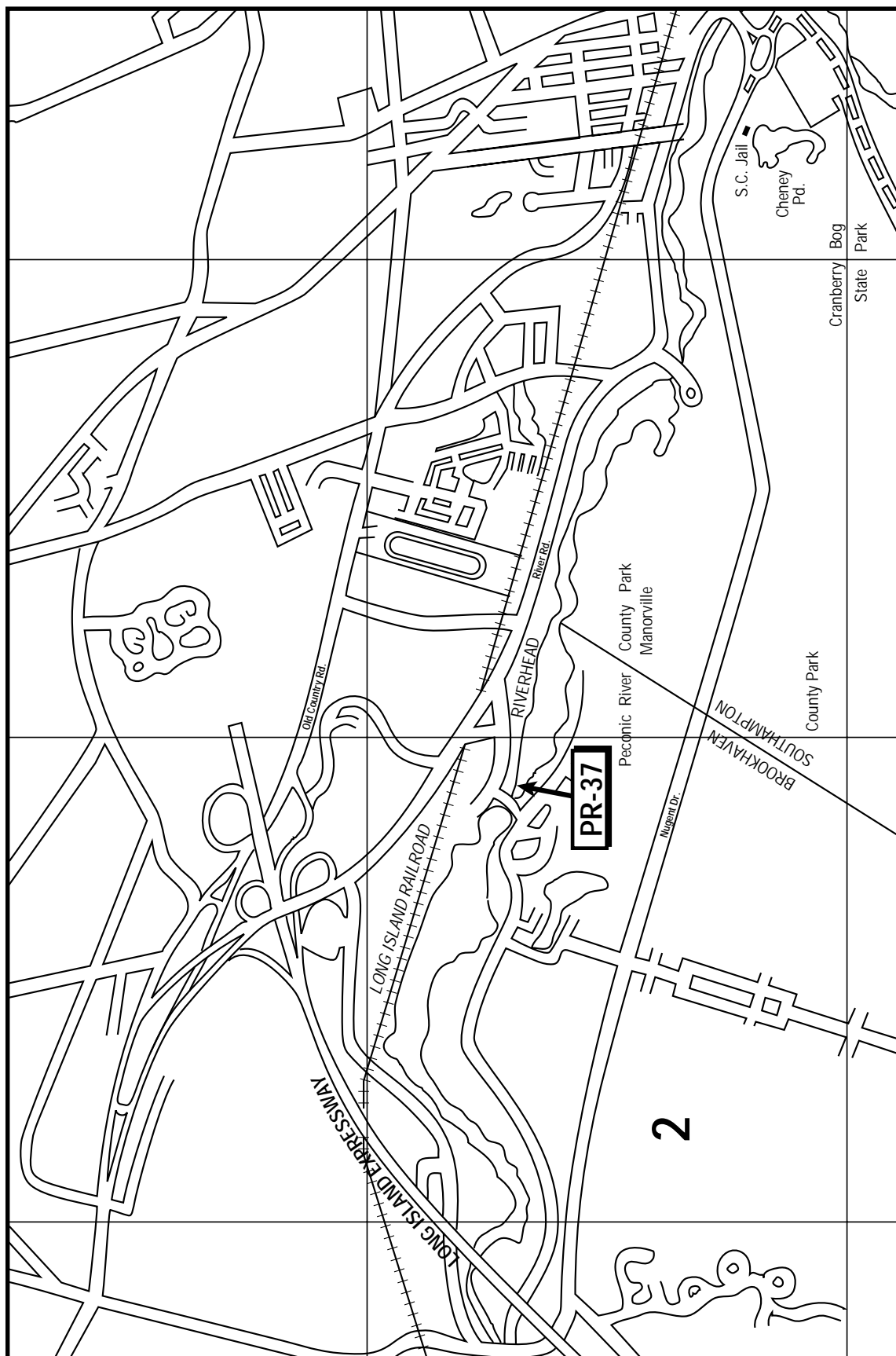


Figure 7-12. Fish Tissue Bioaccumulation Study

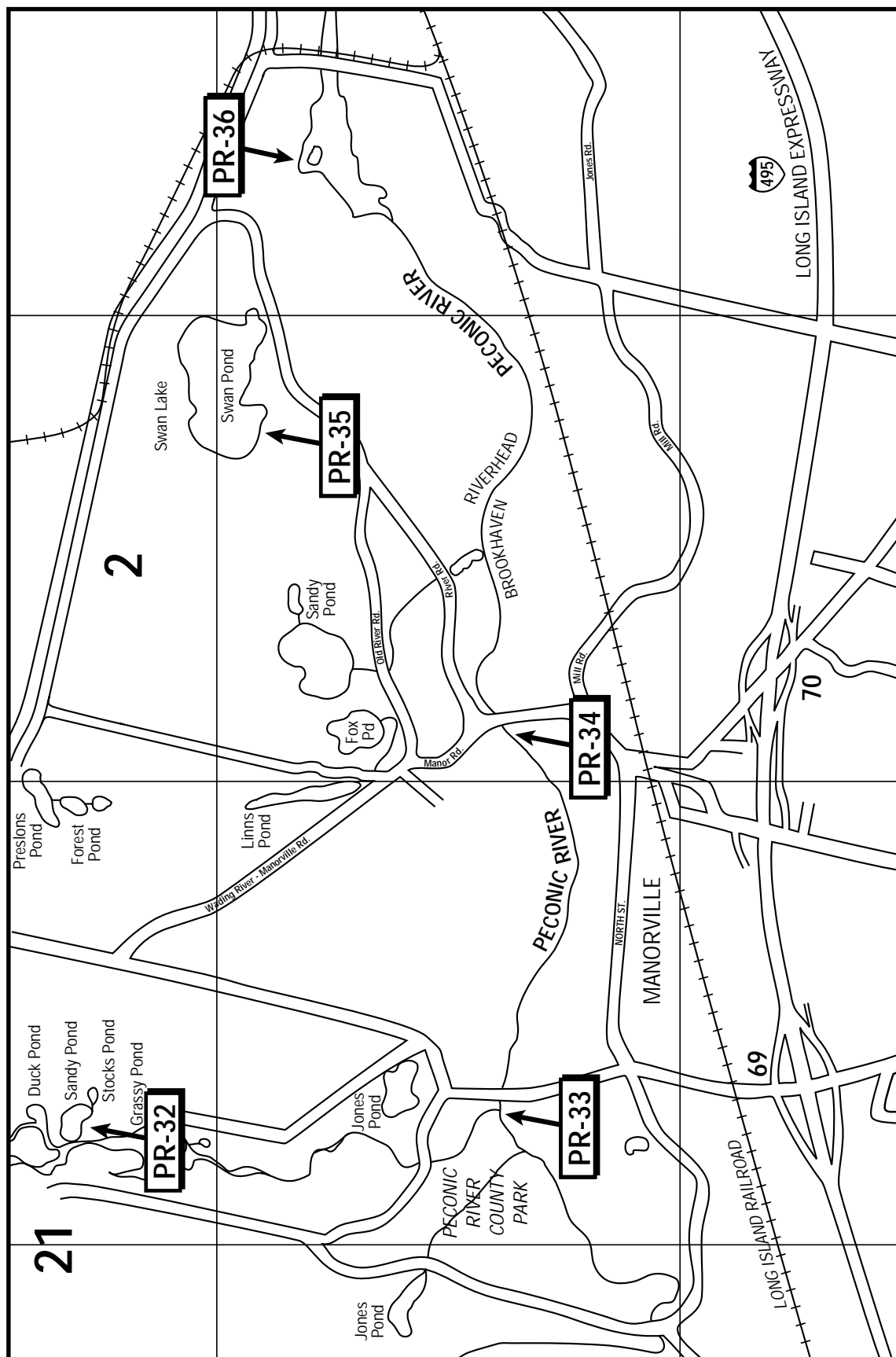


Figure 7-13. Fish Tissue Bioaccumulation Study